Tensions, Trade, and Transformation:
Essays on Chinese Economic History during the Warlord Era

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ABSTRACT

This thesis comprises three chapters on politics, trade, and industrialization during the Warlord Era (1912–1928) in China. The Warlord Era marked the beginning of China's modern history—a pivotal transitional period that remains largely understudied. This thesis offers an in-depth examination of this era by addressing a central puzzle: why did large-scale industrialization take place during this period of persistent political instability? The unique historical context and the rich historical data of this period yield a deeper understanding of the economic transformation not just in China but in other late-developing countries as well.

The first chapter examines the effects of military factions on domestic trade costs. Using newly collected inland transit data from the Chinese Maritime Customs, it shows that bilateral trade costs between a province and a port increased significantly when they were controlled by different military factions. Leveraging the 1917 Russian Revolution as an exogenous supply shock, the chapter further demonstrates that demand for foreign goods was elastic across all regions in China, with poorer regions exhibiting even more elastic demand than wealthier ones. Taken together, these findings show that political instability significantly influenced regional access to foreign goods by shifting domestic trade costs. Given that foreign trade was crucial for China's early industrialization, these results have important implications for understanding regional industrial development.

Building on the first chapter, the second chapter examines the impact of foreign trade access on regional industrial development. It develops a simple model, wherein access to foreign trade influenced private firms' entry decisions through its effect on market prices. In particular, access to foreign capital goods *relative to* foreign consumer goods determined the number of new industrial firms in a region. Better access to foreign consumer goods discouraged industrial firm entry, whereas better access to capital goods encouraged domestic producers to enter the market. This model is then tested by combining the trade costs measured in Chapter 1 with a large dataset of firm entry on the provincial level. These findings highlight the importance of private initiatives in driving industrialization. Private participants, even in a late-developing country like China, actively responded to market incentives. It was their entry that made industrialization possible even during a period of persistent political instability. A liberalized market alone was able to induce some industrialization. At the same time, high domestic trade barriers were not inherently disadvantageous,

as they could offer protection to domestic producers from foreign competition in certain regions.

The third chapter further examines coal markets using a dataset of county-level coal prices and output from 1912 to 1919, newly compiled from archival records of the *Nongshang Tongji Biao* (Survey of Agriculture and Commerce). Adding to the first two chapters, which focus on the movement of foreign goods within China, this chapter turns to a domestically produced good. Consistent with the previous chapters, it finds that political instability introduced trade barriers, that the entry of small private coal mines played a key role in driving market integration, and that limited market integration may have encouraged local mining activities. More important, this chapter revisits Pomeranz's influential argument that China's late industrialization was largely "a geographic accident" (Pomeranz, 2000). While the distribution of coal deposits may reflect geological randomness, the high energy costs faced by China's commercial centers during the Qing were not purely a misfortune of geography but also a consequence of unfavorable institutions.

Returning to the broad question that motivated this research, why did large-scale industrialization occur during a period of persistent political instability? The collapse of the Qing government ushered in both political instability and market liberalization. As two sides of the same coin, they together shaped the economic landscape of the Warlord Era.

First, political instability during the Warlord Era did not lead to widespread physical destruction. Regardless of the warlords' intentions, their lack of modern weaponry and poor military training limited their ability to inflict massive direct damage. Instead, political instability gave rise to an informal political order: military factions. This order introduced additional trade barriers, but it did not generate uncertainty severe enough to deter private investment altogether.

Second, industrialization does not necessarily depend on a centralized state to coordinate resources. The fall of the Qing did not signify the collapse of markets; rather, it opened space for markets to function more freely. Even in a late-developing country like China, private actors responded to market signals. A liberalized market alone, to some extent, was able to direct investment efficiently and promote the adoption of advanced technology.

Third, the absence of a central government indeed hindered the development of transportation infrastructure. However, even if a central government had existed, China would have been unable to implement effective trade policy due to earlier treaties. Under such a condition, lower domestic transportation costs would have facilitated the inflow of manufactured goods from advanced economies into interior regions, which likely exposed domestic producers to overwhelming competition from foreign manufacturers. In this sense, political instability did not necessarily pose challenges to private initiatives.

In sum, industrialization during the Warlord Era occurred because the economic opportunities that market liberalization created for the private sector outweighed the uncertainties introduced by political instability. In some cases, political instability even afforded protection for nascent private industrial enterprises. This is not to suggest that political instability is inherently conducive to economic growth. The collapse of central authority imposed clear limitations: industrial development remained largely confined to the civilian sector, with little progress in heavy industry, and although all regions experienced some growth, regional disparities remained pronounced. More important, the effects of political instability must be evaluated in relation to the nature of the preceding regime. In this case, the breakdown of a highly conservative government such as the Qing indeed created conditions more conducive to economic development.

Finally, the industrial growth witnessed during the Warlord Era invites a counterfactual reflection: what might have occurred under the Qing? Had the Qing embraced market liberalization earlier, similar growth might have emerged sooner. In essence, political stability and market liberalization are not incompatible. However, when the incumbent regime's priorities diverge from economic development, political instability may, paradoxically, open the door for growth.

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FOREIGN TRADE IN TIMES OF CIVIL CONFLICT

1.1 Introduction

Engaging in international trade requires not only moving goods across borders but also transporting them domestically from or to suitable ports. Both international and domestic trade costs therefore play crucial roles in shaping a country's foreign trade. Over the past few centuries, trade costs have undergone significant changes. Following the Industrial Revolution, one major technological advancement, steamships, significantly reduced international trade costs by facilitating maritime transport (Jacks, Meissner, and Novy, 2011). However, global conflicts, particularly World War I, later fractured international markets (Findlay and O'rourke, 2009). Meanwhile, domestic trade costs declined with the expansion of railways (Tang, 2014; Berger, 2019), another transformative transportation innovation of the Industrial Revolution, in many countries. Yet, much less is known about how civil conflict affected domestic trade costs, even though, like World War I, it may have severely disrupted domestic market integration and, in turn, significantly impacted a country's foreign trade.

This paper addresses this gap by examining the effects of civil conflict on domestic trade costs in China during the Warlord Era (1912–1928). In particular, I focus on domestic trade costs associated with the internal movement of goods to and from global markets. In large countries, like China, domestic trade costs play a crucial role in shaping access to foreign trade. Foreign trade access varies across regions within a country because of internal trade barriers (Donaldson and Hornbeck, 2016). This was particularly true for China before 1930. While China's markets had long exhibited some degree of integration, this integration was primarily driven by intertemporal effects rather than reductions in transportation costs (Shiue, 2002). Before the Industrial Revolution, the performance of markets in China and Western Europe was comparable. However, markets in Western European countries quickly integrated after industrialization (Shiue and Keller, 2007). China's vast geography imposed substantial domestic trade frictions (Keller, Santiago, and Shiue, 2017), and limited railway development during the Qing dynasty kept trade costs persistently high (Brown, 1979). In this context, China entered the Warlord Era, a period of civil conflict, which further shaped domestic trade barriers.

The Warlord Era (1912-1928) was a period of political instability following the collapse of the Qing dynasty. During the Warlord Era, China was divided into regions controlled by regional military governors, or warlords. Warlords fought incessantly. Driven by concerns about conflict, warlords continuously formed and restructured military factions. These factions created an informal political order that further influenced domestic trade costs. In particular, this paper examines the effects of military factions on trade between treaty ports and provinces—specifically, the internal movement of imports and exports, or, in other words, the domestic trade costs associated with foreign trade activity in China.

The Warlord Era provides an exceptional setting for studying the effects of civil conflict on domestic trade costs. First, even though armed conflicts were frequent during the Warlord Era, historians believe they were small in scale and caused limited direct destruction primarily due to the lack of modern weapons (Rawski, 1989; Sheridan, 1983). This feature allows me to abstract from direct effects, such as the physical destruction of foreign goods, and focus on the effects of conflict on trade costs. Second, while civil conflict often alters political relationships between regions within a country, these changes are typically difficult to capture. However, during the Warlord Era, military factions were well-documented, which made it possible to formalize the impact of civil conflict on domestic trade costs. Third, foreign trade is typically a decentralized economic activity, and the internal movement of imports and exports is usually difficult to track. However, during the Warlord Era, foreign trade operated under the Treaty Port System, which monitored the flow of imports and exports within China. My study leverages the system's records to examine the domestic trade costs.

The Treaty Port System was one of the most influential economic institutions in modern Chinese history. Under this system, approximately 50 customs stations, or treaty ports, served as the exclusive entry and exit points for foreign and domestic goods. This trade is uniquely well documented, and we can measure the extent to which each province traded with each treaty port. I collect data on the annual trade value between each province and treaty port from the trade reports of the Chinese Maritime Customs (CMC). Overseen by both foreign and Chinese agents, the CMC was responsible for monitoring trade at treaty ports and maintained high-quality records of foreign trade activity even during the Warlord Era, a period of political instability. The CMC reports include both the value of trade between each port and province and the detailed commodity flow at each port.

The importance of the Treaty Port system and the Chinese Maritime Customs (CMC) is well known. The Treaty Port system opened China to global markets, facilitated the exchange of technology and ideas, and played a crucial role in the country's modernization (Keller, Li, and Shiue, 2011; Keller, Li, and Shiue, 2012; Keller and Shiue, 2020; Jia, 2014). Meanwhile, the CMC, responsible for collecting trade duties, functioned as a relatively autonomous tax bureaucracy that contributed to the evolution of China's financial and banking system (Ma, 2019). While many studies have examined the Treaty Port system, to the best of my knowledge, the inland transit data I collect from CMC trade reports have not previously been used by researchers.

To examine the effects of civil conflict, I adopt a structural gravity model with an explicit trade cost function from Anderson and Van Wincoop (2003). This model assumes that any change in trade costs between a province-port pair indirectly affects trade flows for all province-port pairs. This model has been used by several studies, such as Xu (2022) and Berger et al. (2013). Using this framework, I analyze how trade between provinces and treaty ports responded to the changes in military factions. The results indicate that bilateral trade cost increased when the province and the treaty port were controlled by different military factions. The effect of belonging to different military factions on trade costs was equivalent to one-third of the effect of being connected by railway but in the opposite direction. My findings indicate that civil conflict can have significant effects on regional foreign trade access even without causing extensive direct damage. Civil conflict affected the arrival prices of foreign goods in regional markets and the prices of Chinese goods in global markets by influencing the domestic trade costs associated with the movement of imports and exports. These effects could have important implications for regional industrialization.

Furthermore, I provide additional evidence for the counterfactual scenario, i.e., what would have happened had there been no civil conflict. Using the 1917 Russian Revolution as an exogenous supply shock, I show that the demand for foreign goods was elastic. Increases in trade costs naturally led to higher prices of foreign goods in local markets. If conflict had not increased trade costs, the demand for foreign goods would have been much higher. Foreign trade brought advanced manufactures and capital goods into the lagged-behind China. Conflict suppressed local demand for foreign goods and thus left profound impacts on economic development. Additionally, the demand elasticities varied across regions. Although the import demand for foreign goods was always elastic, I find that wealthier areas had relatively less elastic demand than poorer areas who suffered more from conflicts and other adverse trade shocks.

My work contributes to three strands of literature. First, it provides a new perspective on global trade in the first half of the twentieth century. The period from 1870 to 1914 is known as the first wave of globalization, followed by a period of disintegration caused by World War I. Existing literature examines both the expansion of global trade, driven by advancements in transportation that reduced international trade costs, and its contraction, caused by rising international political tensions that increased international trade costs (Jacks, Meissner, and Novy, 2008; Jacks, Meissner, and Novy, 2010; Jacks, Meissner, and Novy, 2011; Solar, 2013; De Zwart, 2016; Chilosi and Federico, 2015; Meissner and Tang, 2018). Despite the rich literature on global trade during this period, domestic trade costs, which also played a significant role in shaping global markets, have received much less scholarly attention. As for China's experience during this period, the existing literature primarily focuses on the growth of treaty port cities (Ma, 2008; Jia, 2014; Liu and Zhang, 2023) or the trade shocks caused by World War I (Mitchener and Yan, 2014; Liu, 2020; Bo, Chen, and Liu, 2022). However, the unique historical context of civil conflict remains largely unexplored. This paper contributes to this strand of literature by offering a novel framework that links foreign trade and domestic politics. Just as World War I disrupted the global market, civil conflict imposed additional domestic trade costs, which in turn affected both China's overall foreign trade and regional access to global markets.

Moreover, my findings enrich discussions on market integration in China. One line of research focuses on price convergence. Using this approach, Shiue (2002) argues that markets in China exhibited a higher level of integration than is usually assumed, particularly because storage substituted for trade in achieving consumption smoothing. Shiue and Keller (2007) argue that the performance of markets in China was comparable to those in Western Europe before the Industrial Revolution but fell behind after European countries industrialized. My work, on the other hand, adopts a different approach by explicitly estimating a domestic trade cost function. Domestic trade was never frictionless in China (Keller, Santiago, and Shiue, 2017). Previous research recognizes the slow development of modern transportation during the Qing. The first railway in China was built by the British in 1876, and over the following two decades, the Chinese government constructed some railways, primarily in the eastern part of the country (Wang et al., 2009). However, by 1911, the overall railway network remained limited relative to China's geographic size. My cost function not only includes common variables from existing studies, such as geographic distance and railway, but also accounts for the impact of civil conflict, which continuously shaped regional political relationships within China. My analysis offers a unique perspective on market (dis)integration in China, extending beyond its complex geography and its failure to develop modern transportation. The significant internal trade costs identified in this study can further inform analyses of how welfare gains from foreign trade varied across regions in China due to internal trade barriers.

Additionally, my work contributes to the broader understanding of conflict and its broader economic consequences. Conflict has been a persistent feature of human history (Rosenthal and Wong, 2011; Hoffman, 2012; Stasavage, 2016; Dincecco and Wang, 2018). Beyond direct destruction, conflict can reshape social and economic networks, alter regional relationships, and drive institutional change (Haber, Maurer, and Razo, 2003; Rohner, Thoenig, and Zilibotti, 2013). Compared to direct damage, these indirect effects are often more difficult to quantify. One of the few studies addressing this issue, Korovkin and Makarin (2023), finds that the 2014 Russia-Ukraine conflict disrupted trade by eroding intergroup trust. My study provides valuable quantitative evidence from a historical perspective. Lasting for more than a decade, the Warlord Era was marked by frequent civil wars that repeatedly reshaped military factions. These recurrent changes offer a rich empirical foundation for analyzing how conflict disrupted economic activity beyond direct destruction. Civil conflict was not unique to China—many countries have experienced domestic upheavals, especially during industrialization and modernization. A large number of people today still live in conflict-ridden countries, even if they are not directly exposed to violence. In this regard, my study offers insights into the role of conflict in economic activity with wider relevance.

The paper proceeds as follows. Section 1.2 provides historical background on the Warlord Era and the Treaty Port system. Section 1.3 describes the data on trade and military factions. Section 1.4 introduces the gravity model and discusses the instrumental variable approach used to estimate demand elasticity. Section 1.5 concludes with an extended discussion and suggests directions for future research.

1.2 Background

1.2.1 The Warlord Era

The Hsinhai Revolution (Oct 10, 1911-Feb 12, 1912) ended the Qing dynasty, China's last imperial dynasty. The Republic of China was established, with Yuan Shih-kai as the first president. Although the transition occurred without much violence, the new form of government did not bring the stability that had been expected. Three years later, in 1915, Yuan Shih-kai decided to restore the hereditary monarchy, by appointing himself as the Hongxian Emperor. Yuan Shih-kai's about-face alienated many of his supporters. China then split into regions under the control of local military leaders. The era of warlords ruling China's regions began in 1916 following Yuan Shih-kai's death and lasted until 1928, when the Kuomintang officially unified the country under Chiang Kai-shek.

During the Warlord Era, warlords fought incessantly. Table 1.1 lays out the major civil wars during this period. There was hardly a year without a "war," not to mention the countless small-scale conflicts occurring nationwide. Yet, despite the frequency of violence, military action caused only limited direct damage. For example, although the total number of troops mobilized during the Chihli-Anhwei War was 120,000, the number of casualties was no more than 3,600. Military action was responsible for less than 1 percent of mortality during the Warlord Era. These figures are in no way comparable to those from wars happening in other countries during the same timeframe.[1] The total number of casualty estimated during the whole Warlord Era was $400,000$, which is not a small number but is almost trivial given China's population size of more than 450 million.[2]

Previous studies have shown that both financial and geographic conditions limited the direct damage caused by warfare. Rawski (1989) points out that most warlords were poorly financed and therefore could not afford large armies. Moreover, many troops had nearly no firearms and thus were incapable of causing massive destruction. Ch'i (1976) finds that the locus of fighting was always restricted. In the mountainous areas, because of inadequate modern communications, armies usually fought in highly concentrated areas and wars only affected the immediate vicinity of the battlefield. Even on the plains, troops were concentrated to defend the main communication arteries and the area of fight was restricted, a strategy that caused

[1] For example, in the Battle of Verdun during World War I alone, nearly two million troops from Germany and France were deployed. French casualties and German casualties all exceeded three hundred thousand at Verdun.

[2] Data on estimated casualties during the Warlord Era come from Rawski (1989), pp. 37–38.

Table 1.1: Major Civil Wars

War	Start	End	Estimated Army[a]
The National Protection War	1915-12-25	1916-07-25	55,000
The Constitutional Proection Movement	1917-07-17	1918-05-21	100,000
The Chihli-Anhwei War	1920-04-09	1920-07-19	120,000
The First Chihli-Fengtien War	1922-04-28	1922-05-05	225,000
The Szechwan War	1923-07-25	1924-02-09	300,000
The Kiangsu-Chekiang War	1924-08-18	1924-10-20	200,000
The Second Chihli Fengtien War	1924-09-15	1924-10-23	450,000
The First Eastern Expedition	1925-02-01	1925-03-20	100,000
The Second Eastern Expedition	1925-10-01	1925-11-30	60,000
The Nankou War[b]	1926-04-15	1926-08-15	600,000
The Northern Expedition	1926-07-09	1928-12-29	1,100,000

[a] The total number of troops mobilized on both sides. Data on the National Protection War, the Constitutional Protection Movement, the Chihli-Anhwei War, the First and Second Chihli-Fengtien Wars, the Nankow War, and the Northern Expedition are drawn from Rawski (1989), Table 1.8, p. 37. Estimates for the remaining wars are based on army organizations detailed in Jiang (2008).

[b] It is generally believed that this battle was a preparation for the Northern Expedition. It attracted the main forces of the Chihli and Fengtien factions, leaving the south vulnerable and effectively supporting the advance of the Northern Expedition.

limited direct destruction but affected the flow of trade.

However, the limited direct damage of warfare should not lead to the conclusion that conflict had no impact on the economy during the Warlord Era. Previous literature finds that one key negative aspect of the Warlord Era was the uncertainty brought by the military. Ch'i (1976) observed that "political unrest and civil wars made any long-range investment extremely precarious."[3] Uncertainty was not the only consequence of conflict. Hsieh (1975) argues that China during the Warlord Era was governed by two interdependent systems: a formal administrative system and an informal political order. The formal system involved a nationwide bureaucratic hierarchy extending from the capital to the smallest village. The informal order captured the fluid and subjective relationships among regional governors and elites, which shaped local and regional trade. Conflict significantly shaped the informal order.

During the Warlords Era, provinces were controlled by different warlords who formed alliances to counter potential threats. Table 1.2 lists major military factions. The first three factions were named by one province, but this does not mean that they

[3] This argument is drawn from Ch'i (1976), pp. 171–172.

only controlled one province. A faction was usually named after the hometown of its key figure. Although a faction usually controlled the province in its name, it could still exist after it had lost that province (an example is given later). The Kuomintang was certainly the best known among these factions. It reunified China under Chiang Kai-shek in 1928 and ruled mainland China from 1927 to 1949. However, during for most of the Warlord Era, the KMT was influential only in southern China. The actual controlled areas of a faction changed over time. The bases listed in Table 1.2 are provinces that each faction held for relatively long time, but they are not the only provinces a faction held nor the provinces a faction always held.

Table 1.2: Major Factions in China 1916-1949

Name	Representative Figures	Bases
Anhwei Faction	Tuan Ch'i-jui	Anhwei, Chekiang, Shantung
Fengtien Faction	Chang Tso-lin	Fengtien, Kirin, Heilungkiang
Chihli Faction	Wu P'ei-fu, Sun Ch'uan-fang	Chihli, Honan, Kiangsi, Hupeh
Kuomintang (KMT)	Sun Yat-sen, Chiang Kai-shek	Kwangtung, Kwangsi

Warlords of the same military faction typically maintained amicable relationships, while warlords from opposing factions were hostile to one another. However, these military factions were not binding. Warlords occasionally changed their factions of their own will. An notable example is a controversial general—Feng Yu-hsiang. Feng was first a follower of Yuan Shih-kai, but he stood on the opposite side of Yuan during the National Protection War. He joined the Chihli Faction in against Fengtien Faction during the First Chihli-Fengtien War, but he chose to betray the Chihli Faction during the Second Chihli-Fengtien War. He later again betrayed the Fengtien Faction and joined the KMT during the Northern Expedition. And he eventually left the KMT and joined the Chinese Communist Party (CCP).

Furthermore, major wars affected the territories controlled by each faction. On the eve of the Anhwei-Chihli War, the Anhwei Faction controlled Shantung, Anhwei, Chekiang, and Fukien. Defeated by the Chihli Faction, the Anhwei Faction lost control over Shantung and Anhwei. The Chihli Faction became the largest faction after it defeated the Fengtien Faction during the First Chihli-Fengtien War. However, it lost control over all the provinces in Northern China after the second Chihli-Fengtien War. Moreover, the Chihli Faction split after the war, with Wu P'ei-fu and Sun Ch'uan-fang each controlling a few provinces.

Clearly, control of a region could oscillate among various military factions. Since warlords acted as the *de facto* civil governors, such shifts imply that the political ties between regions were also in a state of constant flux. These changes in political connections further affected interregional trade. One example is the opium trade: opium from Yunnan and Kweichow was shipped along a well-established trade route to Western Hunan, from where it could be sent either northward to the Yangtze Valley or southward to the Canton delta. The allegiance of the warlord controlling Western Hunan determined which route was selected.[4] Although the opium trade was not encouraged, this example illustrates the link between military alliances and interregional trade. This type of connection has also been recognized in the Chinese Maritime Customs (CMC) trade reports. One report[5] notes that

> The tea trade has not prospered during the decade owing to the great difficulties and risks attending all interprovincial commercial transactions since the inauguration of the Republic, and more especially during the years of warfare between Yunnan and Szechwan.

Despite abundant descriptive evidence, systematic analysis on the economic impact of military factions during the Warlord Era remains limited. Earlier studies tend to downplay the impact of national disintegration. Sheridan (1983) argues:

> The regional power of the warlords did little to strengthen regional divisions in China. [...] The regional units that had cultural and economic importance in a unified China became the natural units into which the country disintegrated, and the natural territorial bases for warlords. But the very fact that the regions had a normal existence within a unified China meant that warlord regionalism was a less destructive force than it might otherwise have been.

Nevertheless, the consequences of political fragmentation may extend beyond what could be directly observed, and they warrant deeper investigation. Expanding on Sheridan's perspective, I argue that while civil conflict did not create new regional units, it nevertheless deepened divisions among existing ones. Concerns about conflict drove changes in military factions, introducing additional divisions that significantly affected domestic trade costs.

[4]This example comes from Sheridan (1983), p. 296.

[5]*Decennial Reports on the Trade Navigation Industries, etc., of the Ports Open to Foreign Commerce in China and Corea, and on the Conditions and Development of the Treaty Port Provinces*, 1912-1921, p.372

1.2.2 The Treaty Port System

After the First Opium War of 1840-1842, the British gained control of five cities on the China coast, namely Shanghai, Canton (Guangzhou), Ningpo (Ningbo), Foochow (Fuzhou), and Amoy (Xiamen). These cities were forcibly opened to foreign trade and became so-called "treaty ports." In the following decades, the Qing government signed several treaties with foreign countries, including the British, the Americans, the French, and the Russians, and eventually more than 40 treaty ports were established in China. All the treaty ports were established before the collapse of the Qing dynasty, but they remained operational throughout the Warlord Era. Initially, most of these ports were established along China's coastline. Later, several were also established in important inland locations. Most provinces possessed at least one treaty port.

Under the Treaty Port system, treaty ports served as the exclusive entry and exit points for foreign trade. All the imports into China and exports out of China had to go through these designated ports. Any region within China had to trade with treaty ports if it sought to acquire foreign goods or export its local products.[6] Therefore, trade between provinces and treaty ports was the only channel through which regions in China accessed global markets. Figure 1.1 presents a map of all the treaty ports. A total of 44 ports were in operation during the Warlord Era.[7]

Founded in 1854 in Shanghai by foreign consuls, the Chinese Maritime Customs was in charge of collecting trade taxes to ensure that China would pay indemnities owed after military defeats. Later, it established stations in most treaty ports. The CMC collected treaty port data on the value and the quantity of imports, exports, re-exports, inland transit, etc. The quality of the data is usually considered to be high because most CMC employees were highly skilled graduates of universities such as Cambridge, Harvard, and Yale, who were accountable to both bondholders and the Chinese treasury (Keller, Li, and Shiue, 2011). A detailed description of the Treaty Port system and the Chinese Maritime Customs can be found in Keller and Shiue (2020).

Although the Treaty Port system's origins stem from military defeats, it became

[6] In the remaining text, I use "foreign goods" and "imports" interchangeably. They both refer to goods produced outside China and brought into China through treaty ports. I use "native goods" and "exports" to refer to goods produced within China that are targeted at overseas markets.

[7] In the trade reports, trade at Sansing and Suifenho was counted under Harbin, and Tatungkow was included in Antung for most years. Therefore, these three ports have been excluded. Manchouli (in today's Inner Mongolia) was also removed.

Figure 1.1: Treaty Ports

Figure 1.1 displays a map of the treaty port system. Red dots indicate treaty ports, while blue text provides their names. The labels enclosed in rectangles represent provinces in China. A total of 44 ports were actively engaged in trade during the Warlord Era.

one of the most important economic institutions that accelerated China's transformation into a modern, industrialized economy. It ensured the operation of foriegn trade even during the period of national disintegration. Every year, hundreds of foreign commodities were brought into China, facilitating the transfer of advanced technology from the Industrial Revolution. Exports of Chinese specialties, such as silk, tea, and handicrafts, also brought in significant revenue from international markets. As Rawski (1989) noted, foreign trade was the root of economic growth in China during the Warlord Era. This paper seeks to link the era's prominent political features, military factions, with foreign trade, the most important economic activity of the time.

1.3 Data

1.3.1 Trade Data

The main trade dataset is based on the **Inland Transit** section of the reports published by the Chinese Maritime Customs (CMC). My dataset documents the annual value of foreign goods (imports) and native goods (exports) that transited between each province-port pair during 1912-1928 under the Transit Pass.[8] Provinces traded with treaty ports to buy foreign goods or sell native products. The trade between provinces and treaty ports occurred within China but it involved goods that were either imported from foreign countries or about to be exported abroad.[9] My dataset documents the aggregate imports value and aggregate exports value for each province-port pair. However, it does not detail the values for individual commodities. Commodity-level data unfortunately did not exist for trade between provinces and treaty ports during the Warlord Era.

Although province-port trade data do not include details on commodity composition, I address this limitation by further collecting data on the commodity-level imports and exports at each treaty port from the **Analysis of Foreign Trade** section in CMC trade reports. This dataset provides the quantity and the value of each commodity imported or exported annually *at each port*. However, as mentioned, each port engaged in trade with multiple provinces, so this port-level dataset does not explicitly reveal the composition of trade for a specific province-port pair. Nevertheless, it could still provide important implications for the possible commodities that provinces traded with each port.

I merge Fengtien (Liaoning), Kirin (Jilin), and Heilungkiang (Heilongjiang) into Manchuria (Manzhousheng), as some trade reports group these three provinces in this way. I also exclude trade data from provinces that not actively involved in China's domestic affairs during the Warlord Era, e.g., Sinkiang, Mongolia, and Chinghai. To ensure that values are comparable across years, I convert all values to

[8] The system of transit passes was initially created to give foreign merchants the option of either paying all internal taxes as the were levied by local officials, or instead receiving an exemption from all further taxes by paying the Maritime Customs a fifty percent surcharge on the regular customs duties. Chinese merchants were included after 1876. Transit passes could be purchased for both foreign imports shipping to inland areas and inland goods being shipped to treaty ports. There were controversies regarding the implementation of policies. See Matthews (1999) and (Brown, 1978).

[9] For example, consider Province A, Province B, and Port C. Foreign goods imported from Port C to Province A would be recorded as imports from Port C to Province A. However, if Province B subsequently purchased these goods from Province A, such transactions would not be captured in our dataset. Nevertheless, I argue that this type of inter-provincial trade (trade between Province A and Province B) was likely limited, as trade with treaty ports was protected by transit passes, whereas trade between provinces that bypassed treaty ports lacked such protection.

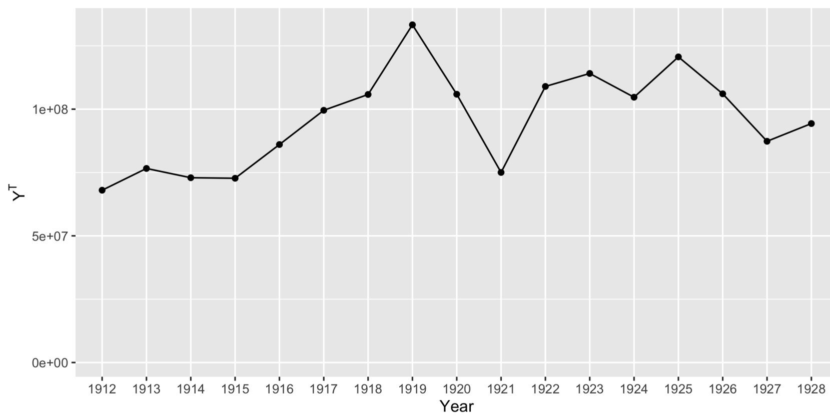

Figure 1.2: Total Value of Trade

Figure 1.2 presents the total trade value between provinces and treaty ports. Although the total value varied over the years, it never collapsed. Each year, trade flows between provinces and treaty ports amounted to millions of dollars.

1907 USD. The annual exchange rates between the currency used by the CMC and the US dollar were provided in the CMC reports, and I adjusted all dollar values to their 1907 USD equivalents using the Consumer Price Index.[10]

Figure 1.2 presents the total trade value between provinces and treaty ports. Although the total value varied over the years, it never collapsed. Each year, trade flows between provinces and treaty ports amounted to millions of dollars. However, the trade value of individual province-port pairs exhibited more fluctuations. Figure 1.3 plots the annual trade value between Chihli and Hankow. Chihli (later called Hopeh, or Hebei) was the province surrounding Peking (Beijing), while Hankou (Wuhan) in Hupeh (Hubei) was one of the largest treaty ports. Figure 1.3 shows that in some years, Chihli and Hankow engaged in intensive trade, whereas in other years, no trade occurred at all. This paper explains fluctuations in trade value by examining domestic trade costs, in which military factions played a significant role.

In the Appendix, Table 1.A1 and Table 1.A2 provide additional summary statistics for aggregate trade flows (imports plus exports) and import flows between provinces and treaty ports.

[10]The Consumer Price Index is retrieved from the Federal Reserve Bank of Minneapolis: https://www.minneapolisfed.org/about-us/monetary-policy/inflation-calculator/consumer-price-index-1800-

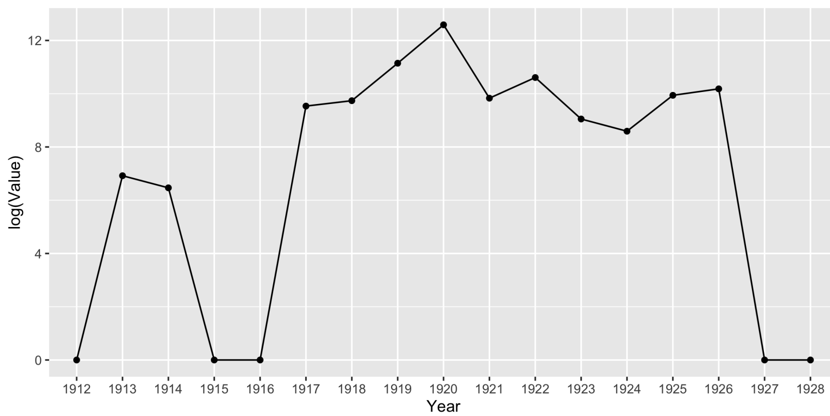

Figure 1.3: Trade Value between Chihli and Hankow
Figure 1.3 plots the annual trade value between Chihli and Hankow. Compared to the total trade value, the trade value between a specific province-port pair exhibits sharper fluctuations. In some years, Chihli and Hankow engaged in intensive trade, whereas in other years, no trade occurred at all.

1.3.2 Faction Data

The classification of military factions is based on Sheridan (1983) and Jiang (2008). I assign each province to a military faction for each year. In addition to the major factions mentioned in the previous section, there were also smaller factions. Some of these smaller factions controlled only one province for most of the period (e.g., Yen Hsi-shan's Shansi), while others existed only briefly. It should be noted that the unit of analysis in my dataset is the province. Occasionally, a province was divided; in such cases, I assign the province to the faction controlling the largest portion. If the province was mired in turmoil (as was the case with Szechwan), I classify it as a separate faction due to the difficulty in determining its dominant faction. It is important to note that although conflicts sometimes occurred within rather than between provinces, as Sheridan (1983) points out, China's basic regional units, provinces, remained largely intact.

1.4 Empirical Framework

1.4.1 Gravity Model

To recover trade costs and the impact of conflict, my primary estimating equations are based on a gravity model of trade. The model relates bilateral trade flows to the economic sizes of countries and various factors influencing trade barriers. The underlying logic is that trade flows tend to be higher between larger economies with lower trade barriers. I adopted the specification from Anderson and Van Wincoop (2003), which has also been employed by Xu (2022), Berger et al. (2013), etc.

The gravity equation gives,

$$V_{ijt} = \frac{Y_{it} \cdot Y_{jt}}{Y_t^T} \left[\frac{\tau_{ijt}}{P_{it} P_{jt}} \right]^{1-\sigma}. \tag{1.1}$$

V_{ijt} denotes the trade flow between Province i and Port j during Year t. Y_{it}, Y_{jt}, and Y_t^T are the size terms for Province i, Port j, and the entire economy in Year t, respectively. The parameter σ (> 1) is the elasticity of substitution between goods. τ_{ijt} measure the bilateral trade cost between Province i and Port j in Year t. P_{it} and P_{jr} are multilateral resistance terms for Province i and Port j, which are complex non-linear functions of the full set of bilateral cost barriers τ_{ijt}. In this model, a change in the bilateral trade cost between any province and port will impact all the trade routes.

Taking natural logs and rearranging gives:

$$\log(V_{ijt}) = \log(Y_{it}) + \log(Y_{jt}) - \log(Y_t^T) + (1-\sigma)\tau_{ijt} - (1-\sigma)[\log(P_{it}) + \log(p_{jt})] \tag{1.2}$$

I assume that the trade cost function contains four variables: $Diff\_Faction_{ijt}$, $Distance_{ij}$, $Railway_{ij}$, and $River_{ij}$. $Diff\_Faction_{ijt}$ is the variable of interest. It is binary variable that measures whether Province i and Port j's province were in different factions in Year t. $Distance_{ij}$ measures the geographic distance between Province i and Port j. $Railway_{ij}$ measure whether Province i and Port j's province were connected by a railway line. Notice that this variable is not time-varying because during the sample period, there was hardly any new inter-provincial railway. $River_{ij}$ indicates whether Province i and Port j were both along the Yangtze River. This variable aims to control the accessibility of river transportation for trade between Province i and Port j. Given the underdevelopment of modern transportation in China during that period, being able to use Yangtze River could possibly reduce trade costs. The trade cost function is given by:

$$\tau \equiv e^{\mu_1 \ln(Distance_{ij}) + \mu_2 I_{ij}^{Railway} + \mu_3 I_{ij}^{River} + \nu I_{ijt}^{Diff\_Faction}}. \tag{1.3}$$

Therefore, the estimating equation is given by

$$\log(V_{ijt}) = \alpha_1 \log(Distance_{ij}) + + \alpha_2 I_{ij}^{Railway} + \alpha_3 I_{ij}^{River} + \beta I_{ij}^{Diff\_Faction} + \gamma_{it} + \gamma_{jt} + \epsilon_{ijt} \tag{1.4}$$

The terms $\log(Y_{it})$, $\log(Y_{jt})$, $\log(Y_t^T)$, and $(1-\sigma)[\log(P_{it}) + \log(p_{jt})]$ are all absorbed by Province-Year fixed effects (γ_{it}) and Port-Year fixed effects (γ_{it}). The coefficients are defined as $\alpha \sim (1-\sigma)\mu$ and $\beta \sim (1-\sigma)\nu$. That is to say, I cannot estimate σ and parameters in the trade cost function separately. The estimated coefficients must be interpreted as relative to each other. The variable of interest is β, which measures the impact of belonging to different factions on trade flows.

Table 1.3 presents the results.[11] The first three columns estimate the effects of military factions on total trade value, the sum of imports and exports. The last three columns estimate the effects on imports only. Across all columns, belonging to different military factions had a significant negative impact on trade flows, which, in other words, indicates a significant increase in trade costs. In particular, although I cannot interpret the coefficients directly, a comparison suggests that the effect of belonging to different military factions on trade costs was roughly one-third of that of being connected by railway, but in the opposite direction. Consistent with findings in many other studies, railway connections significantly reduced domestic trade costs. Belonging to different military factions, on the other hand, introduced extra barriers.

It should be noted that all the results presented here indicate correlation rather than causality. It could be that trade influenced faction changes. However, endogeneity is not a major concern in this context. First, historical records allow me to identify the reasons behind changes in military factions, most of which were triggered by personal relationships among warlords or differences in political ideology, rather than by considerations about trade access. For example, the First Chihli-Fengtian Conflict in 1922 was triggered by their opposing attitudes toward Japan. Second, even when warlords took foreign trade access into consideration, they likely avoided decisions that would severely harm their provinces' foreign trade access. Therefore, there is likely a self-selection bias leading to an underestimation (in absolute value) of the effects of military factions.

The coefficients in Table 1.3 are the product of $(1-\sigma)$ and μ or ν. I cannot separate these two components without knowing the value of σ. Suppose I set σ to 8, a value commonly used in the literature when varieties are somewhat similar. This value is chosen because, although the available commodities differed across ports, many

[11] The sample used for the baseline estimation of Equation 1.4 includes all province-port pairs that engaged in trade at least once during the study period. For periods when they did not trade, their trade flows are coded as 0. Province-port pairs that never traded during the sample period are excluded, as is standard practice in the gravity model literature. See Helpman, Melitz, and Rubinstein (2008) for a discussion on the intensive margin and the extensive margin in gravity models. Moreover, in Table 1.A3, I present robustness checks that incorporate all possible province-port combinations, including those pairs that never traded. The results remain similar to the baseline findings.

Table 1.3: The Effects of Military Factions on Trade Between Provinces and Ports, 1912-1928

Dependent Variable:	log(Value+1)					
	Imports + Exports			Imports Only		
	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
Constant	21.47***			20.84***		
	(0.5453)			(0.5348)		
log(Distance+1)	-2.317***	-3.318***	-2.376***	-2.242***	-3.192***	-2.236***
	(0.0905)	(0.1166)	(0.1252)	(0.0848)	(0.1392)	(0.1634)
Diff_Faction	-0.7822***	-1.905***	-1.198***	-0.7381***	-1.848***	-1.134***
	(0.2161)	(0.2765)	(0.2782)	(0.2156)	(0.2764)	(0.2724)
River			1.848***			1.670***
			(0.4215)			(0.4084)
Railway			3.932***			4.053***
			(0.3568)			(0.3530)
Fixed-effects						
Port Year		Yes	Yes		Yes	Yes
Province Year		Yes	Yes		Yes	Yes
Fit statistics						
Observations	3,383	3,383	3,383	3,383	3,383	3,383
R^2	0.19728	0.53104	0.56576	0.18947	0.52541	0.56296
Within R^2		0.34959	0.39774		0.33636	0.38887

Note: This table reports regression results from the following equation: $\log(V_{ijt}) = \alpha_1 \log(Distance_{ij}) + \alpha_2 I_{ij}^{Railway} + \alpha_3 I_{ij}^{River} + \beta I_{ij}^{Diff\_Faction} + \gamma_{it} + \gamma_{jt} + \epsilon_{ijt}$. The dependent variable is the value of trade between Province i and Port j in Year t. The first three columns combine both imports and exports, while the last three columns include only imports. The key variable of interest is $Diff\_Faction$, a binary indicator for whether the province and the port belonged to different military factions. The results show that belonging to different military factions significantly reduces trade value, indicating a substantial increase in bilateral trade costs.

Clustered (Province_Year) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

goods were still shared among them, making trade flows "similar." This assumption yields the following trade cost function:

$$\tau_{ijt} = e^{0.339 \log(Distance_{ij}+1) + 0.171 I_{ij}^{DiffFaction} - 0.264 I_{ij}^{River} - 0.562 I_{ij}^{Railway}}.$$

Under this specification, belonging to different military factions increased bilateral trade costs by 17%.

The last three columns in Table 1.3 indicate that the trade cost function recovered from total trade was roughly the same as the trade cost function recovered from imports only. This is not surprising, as imports constituted the majority of China's foreign trade activity. Imports brought in advanced manufactured goods and capital goods, which could hardly be produced domestically and were crucial for regional industrialization. The last column indicates that belonging to different military factions would increase trade costs by 16% (assuming $\sigma = 8$). This means that the arrival prices of foreign goods from a treaty port would be 16% higher if the province and the treaty port belonged to different military factions.

1.4.2 Counterfactual Analysis

The results above have shown that provinces belonging to different factions faced significantly higher trade costs, but what remains unanswered is the counterfactual scenario: what would trade have been like if there had been no conflict? I cannot provide a direct answer to this question, but I can gauge the significant influence of the increases in trade costs by estimating the demand elasticity for foreign goods. The rise in trade costs caused foreign goods' prices in local markets to increase, and demand elasticity indicates how demand reacted to these higher prices. In this subsection, I focus on imports and show how the demand for foreign goods responded to price changes.

The following analysis hinges on the assumption that increases in trade costs led to higher prices for foreign goods in the local market. Unfortunately, this assumption cannot be justified with concrete numbers because local prices data, especially for foreign goods, are largely unavailable for China during the Warlord Era. However, this assumption conforms to the natural laws of economics and the CMC trade reports also support this assumption. For example, in CMC's Decennial Report for Szemao (Simao, Sichuan), it mentions that the steadiness in the local price of rice was due to the internal barriers.[12] Conflict nevertheless enhanced this inaccessibility. Moreover, in its report for Canton (Guangzhou, Guangdong), it notices political unrest seriously affected trade and caused shortage of necessities and high prices.[13]

I digitize the commodity-level imports at all the treaty ports ($N = 44$) for 1912-1926 from the CMC reports. There are hundreds of commodities. Some examples include cotton blankets, beans, iron and mild steel wire, candles, coal, agricultural machinery, and etc. For most commodities, I have both value and quantity data, so I can calculate their unit prices. Since treaty ports were the exclusive entry points for foreign goods, the demand for foreign goods recovered at these ports could largely represent that of the entire country.

The naive OLS yields biased results. Consider a simple equation relating price and

[12] *Decennial Reports on the Trade Navigation Industries, etc., of the Ports Open to Foreign Commerce in China and Corea, and on the Conditions and Development of the Treaty Port Provinces*, 1912-1921, p. 384

[13] *Decennial Reports on the Trade Navigation Industries, etc., of the Ports Open to Foreign Commerce in China and Corea, and on the Conditions and Development of the Treaty Port Provinces*, 1912-1921, pp. 226-227

quantity. That is, $Price = \beta \cdot Quantity + \epsilon$. $Price$ and $Quantity$ are both observed in equilibrium. $\hat{\beta}$ from naive OLS can be biased either positively or negatively. If one considers the demand only, then an increase in ϵ leads to an increase in $Price$, which tends to drive down the quantity demanded, so $cov(Quantity, \epsilon) < 0$. However, the market outcome is the point where demand and supply intersects. So one also needs to think from the supply side. From the supply side, an increase in ϵ leads to higher price, which boosts quantity supplied. In this case, $cov(Quantity, \epsilon) > 0$. As a result, the bias can go either way.

I therefore uses the 1917 Russia Revolution as an exogenous supply shock to estimate the demand. Russia was an important trade partner of China at that time, exporting hundreds of commodities to China every year. However, the revolution in 1917 disrupted the production within Russia, leading to decreased in China's imports from it. Table 1.4 shows that the imports from Russia collapsed after the revolution and had not recovered by the end of the sample period. This shock was exogenous to China. Moreover, the degree of the shock varied by port and commodity. Ports closer to Russia traded with it more tightly before the revolution and felt the shock more strongly. Commodities that Russia mainly supplied were impacted more by the revolution.

Inspired by the shift-share instrument, my IV for the quantity of each commodity at each port is given by:

$$IVQ_{i,c,t} = d_i \cdot Q_{Russia,c,t} + r_{i,c} \cdot Q_{Rest,c,t}, \tag{1.5}$$

for $t = 1917 - 1926$. $Q_{Russia,c,t}$ is the imports of Commodity c from Russia in Year t and $Q_{Rest,c,t}$ is the imports from the rest of the world. d_i is the share of Russian supply for Port i, which is inversely related to its distance to Russia.[14] $r_{i,c}$ is the share of imports from countries other than Russia for Port i, which is calculated using pre-trends data (1912-1916). That is, $d_i = \frac{e^{-\log(Dist_{Russia,i})}}{\sum_{j=1}^{N} e^{-\log(Dist_{Russia,j})}}$ and $\tilde{r}_{i,c} = Average_{1912 \leq t \leq 1916}(\frac{Q_{i,c,t}}{Q^T_{c,t} - Q_{Russia,c,t}})$. Note that for each c, the sum of $\tilde{r}_{i,c}$ across all the ports may not exactly equal to 1. $r_{i,c}$ is the rescaled $\tilde{r}_{i,c}$, so that for each c, $\sum_i r_{i,c}$ equal 1.

The first part of this IV measure the accessibility of a port to imports from Russia, which, because of the revolution, was largely exogenous to China's demand. The

[14] The distance to Russia is computed as the great-circle distance from each treaty port to Vladivostok using geographic coordinates.

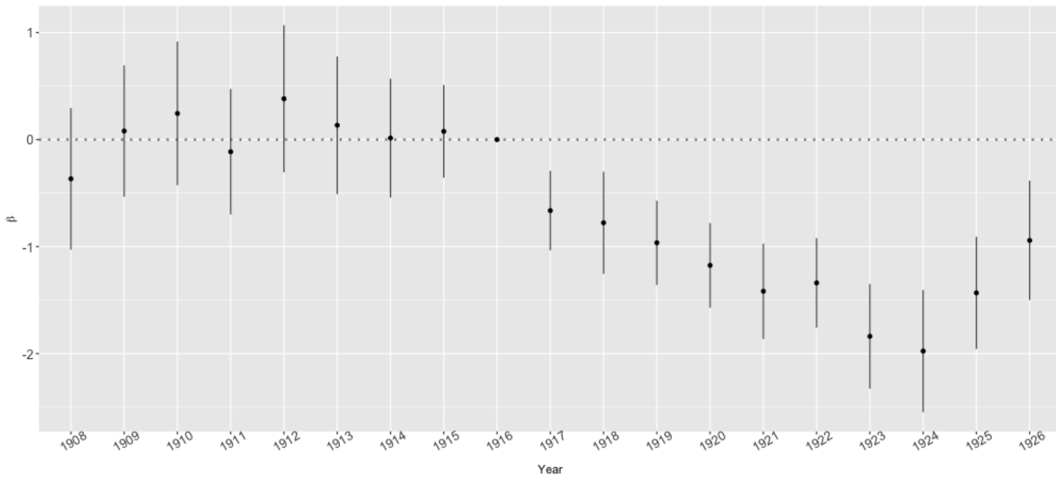

Figure 1.4: China's Imports From Russia by Year

Figure 1.4 plots the estimated β in the regression $\log(Value_{o,c,t}) = \beta Russia_o * Year_t + \alpha Year_t + \gamma_o + \gamma_t$, where $Value_{o,c,t}$ is the total value of Commodity c from Country o in Year t. $Russia_o$ indicates where the origin country is Russia. $Year_t$ is a categorical variable indicating the year. γ_o and γ_t are the Origin fixed effects and Year fixed effects respectively. The reference is year 1916. The estimated results show that Russia's exports to China collapsed after the revolution and had not recovered by the end of the sample period.

second part borrows the idea of the shift-share instrument. The averaged share of the previous years is likely unrelated to later demand.[15]

Then I estimate a simple (inverse) demand equation,

$$\log(Price_{ict}) = \beta \log(Q_{ict}) + \gamma_i + \gamma_c + \gamma_t + \epsilon_{ict}, \tag{1.6}$$

where Q_{ict} was instrumented by IVQ_{ict} defined above. γ_i, γ_c and γ_t are Commodity fixed effects, Port fixed effects, and Year fixed effects respectively.

Table 1.4 presents the results. The first thing to note is the number of observations. As mentioned above, there are hundreds of commodities. The large number of commodities brings noises to my estimation. Therefore, following the classification in the CMC reports, I classify all the commodities into 9 categories: cotton textile (e.g., shirts, sheetings), other textile (e.g., woollen, silk), animal products (e.g., bones, skins), vegetable products (e.g., cereals, fruits), other daily goods (e.g., paper,

[15]The reason I do not weight imports from countries other than Russia by distance is that Russia lies to the north of China and shares a land border with it. In this case, geographic distance is closely linked to trade intensity. In contrast, most other countries—primarily in Europe or the Americas—shipped goods by sea, making the geographic distance between those countries and treaty ports less relevant to their trade intensity.

stationary), chemical products (e.g., acids, wax), industrial products (e.g., bedsteads, electronic devices), raw materials (e.g., coal, wood), and metal and minerals (e.g., iron and steel, copper). I merge all the commodities in each category. That is to say, c in the equation actually represents class, not commodity. I also perform the same analysis on commodity-level, and I get qualitatively similar results.

The first two columns represent the results from the full set of data. Both OLS and IV regressions show that the demand elasticity, $\sigma_d = 1/\beta$, is greater than 1 (in absolute value). In other words, the demand was elastic. Column (3) and Column (4) show the results for daily goods and industrial goods separately. I assume that the first five categories are daily goods, while the last four are industrial goods. The key difference between these two types of goods is that daily goods required less technology and China could produced them itself, while industrial goods were more difficult to produce and China were not able to produce many of them. The results are not surprising. Given China could not produce many industrial goods, it had to rely on foreign supply, so the demand was less elastic. But even for industrial goods, the demand elasticity was still greater than 1.

The last two columns present the results for large treaty ports (i.e., Shanghai, Tientsin (Tianjin), Canton (Guangzhou), Hankow (Wuhan), and Dairen (Dalian)) and small treaty ports separately. They show that although demand was elastic in both cases, large treaty ports exhibited relatively less elastic demand. There are two possible explanations. One is that the commodity structures at large treaty ports differed from those at small treaty ports. Large treaty ports sold essential industrial products that were unavailable at small treaty ports, and the relatively less elastic demand at large treaty ports was driven by these valuable but exclusive commodities. The other explanation is that differences in elasticities were driven by varying levels of wealth. Although each treaty port typically traded with multiple provinces, a significant portion of its trade was concentrated in the surrounding areas. Large treaty ports were located in wealthier regions and, on average, reflected the demand of wealthier populations in China.

I test the first explanation by including only the commodities that appeared at least at 35 ports each year. That is, when I create categories described above, I include only generally available commodities and merge their values and quantities. This way ensures that the compositions of each category were similar for all the ports. Table 1.5 presents the results. Note that the number of observations decreases a bit when I strict my sample, because the price or the quantity is not longer available for some ports for some categories. Column (1) and (2) in Table 1.5 show the results of OLS and IV for the full sample. The estimates are very close to those in Table 1.4. Column (3) and Column (4) in Table 1.5 show the results for large treaty ports and small treaty ports separately. The difference between their estimates becomes smaller compared to that in Table 1.4 but still exists. The results suggest that commodity structures may partially explain the difference in demand elasticities between large ports and small ports, but wealth effects also existed.

Columns (3) and (4) in Table 1.5 demonstrate that people of different wealth levels exhibited varying demand elasticities. Specifically, wealthier individuals tended to have less elastic demand. These results offer valuable insights into regional disparities in China. Poor areas were more sensitive to price change, so their demand for foreign goods was reduced more significantly by price increases caused by conflict. Although conflict affected both wealthy and poor areas, it impacted poor regions more. Beyond causing an overall decrease in demand for foreign goods, conflict also created disparities across regions via shifting domestic trade costs.

Table 1.4: Demand Elasticity Using the 1917 Russian Revolution as a Supply Shock

Dependent Variable:	log(Price)					
Model:	(1) OLS	(2) IV	(3) Daily	(4) Industrial	(5) Large	(6) Small
Variables						
log(Quantity)	-0.4075***	-0.4775***	-0.4217***	-0.6665**	-0.8183***	-0.4564***
	(0.0515)	(0.0874)	(0.0798)	(0.2053)	(0.0987)	(0.0852)
Fixed-effects						
Commodity	Yes	Yes	Yes	Yes	Yes	Yes
Port	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	3,918	3,918	2,179	1,739	450	3,468
R^2	0.78093	0.77598	0.77150	0.76583	0.90054	0.77301
Within R^2	0.43398	0.42118	0.40165	0.38745	0.65967	0.41509

Note: This table reports regression results from the following equation: $\log(Price_{ict}) = \beta \log(Q_{ict}) + \gamma_i + \gamma_c + \gamma_t + \epsilon_{ict}$. Column (1) reports the OLS estimation results, while Columns (2)–(6) present IV estimations using the 1917 Russian Revolution as an exogenous supply shock. Columns (1) and (2) display results based on the full sample. Columns (3) and (4) report results separately for daily goods and industrial goods, respectively. Columns (5) and (6) show results separately for large and small treaty ports, respectively. Demand elasticity is consistently high across all specifications, although the magnitude varies depending on the type of goods and the size of treaty ports.
Clustered (Commodity) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 1.5: Commodity Structures Not Entirely Drive Elasticity

Dependent Variable:	log(Price)			
Model:	(1) OLS	(2) IV	(3) Large	(4) Small
Variables				
log(Quantity)	-0.3890***	-0.4713***	-0.6902***	-0.4618***
	(0.0450)	(0.1088)	(0.1315)	(0.1055)
Fixed-effects				
Commodity	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Port	Yes	Yes	Yes	Yes
Fit statistics				
Observations	3,881	3,881	450	3,431
R^2	0.77751	0.77082	0.87280	0.76468
Within R^2	0.40176	0.38377	0.48383	0.38217

Note: This table reports regression results from the following equation: $\log(Price_{ict}) = \beta \log(Q_{ict}) + \gamma_i + \gamma_c + \gamma_t + \epsilon_{ict}$. Only generally available commodities are included in this analysis. Column (1) reports the OLS estimation results, while Columns (2)–(4) present IV estimations using the 1917 Russian Revolution as an exogenous supply shock. Columns (1) and (2) display results based on all the treaty ports. Columns (3) and (4) report results separately for large and small treaty ports, respectively. The findings indicate that demand elasticities differ between large and small treaty ports even after controlling for differences in commodity structures, suggesting that demand elasticity could vary with wealth levels.
Clustered (Commodity) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Summary of Results

Employing a gravity model and trade flows between provinces and ports, I show that conflict created shifting trade barriers within China. Provinces belonging to different military factions faced higher trade costs. Using the 1917 Russian Revolution as an exogenous supply shock, I estimate demand elasticity using import data at treaty ports. Together, these analyses suggest that civil conflict significantly impacted a region's access to foreign trade. By increasing trade costs, civil conflict drove up the prices of foreign goods in local markets. Given that consumers were sensitive to price changes, these price increases effectively reduced demand for foreign goods. Moreover, demand elasticity varied by wealth. Richer areas exhibited less elastic demand than poorer areas. Therefore, civil conflict affected foreign trade activity unevenly across regions in China.

1.5 Conclusion and Avenues for Future Research

International trade costs were important in global trade, while a country's foreign trade activity was also influenced by domestic trade costs associated with the internal movement of imports and exports. This paper highlights the connection between foreign trade and domestic politics. Using a gravity model, I show that, like World War I, civil conflict significantly impacted domestic trade costs. Furthermore, leveraging the 1917 Russian Revolution as a supply shock, I demonstrate that the demand for foreign goods in China was elastic. Demand elasticity also varied across regions. This implies that the increase in trade costs caused by civil conflict led to a decline in the demand for foreign goods, both nationally and disproportionately across regions.

These findings have important implications for future research. The first wave of globalization integrated many late-developing countries into global markets, prompting the onset of their industrialization. An immediate next step is to further investigate the role of foreign trade in industrialization. Two key aspects warrant particular attention. First, as demonstrated in this paper, foreign trade access was uneven across regions due to domestic trade barriers. Therefore, analysis should be conducted at the regional rather than the national level. Second, while foreign trade facilitated the transfer of advanced technology, the influx of inexpensive manufactured goods from more developed economies also created competition for domestic producers, potentially hindering industrialization. Thus, it is crucial to distinguish between different types of foreign goods.

The Warlord Era provided an ideal setting for this next step. Despite ongoing civil conflict, thousands of modern factories were established during this period. However, as Rawski (1989) points out, China's industrialization at the time was primarily a regional phenomenon. The observed regional disparities can potentially be explained through the lens of foreign trade access. The trade cost function recovered in this paper can be used to measure foreign trade access at the regional level, while the variations in foreign trade access induced by civil conflict can potentially be leveraged to establish causality.

Finally, back to conflict, it is noteworthy that during the Warlord Era, conflict caused relatively limited direct destruction due to the lack of modern weapons. However, in today's world, conflict can lead to economic disintegration by introducing trade barriers and can also result in large-scale direct destruction. From this perspective, my findings reveal one of the many consequences of conflict.

1.A Additional Statistics and Regressions

Year	Mean	Median	SD	Min	Max	N
1912	531314.21	61430.04	1674379.58	11.43	16673975.76	128
1913	617759.22	72712.49	1886910.77	68.15	18218438.03	124
1914	544346.96	50334.58	1714772.19	6.24	17100121.08	134
1915	550954.85	73623.23	1622188.92	10.87	15659817.67	132
1916	661839.14	81472.82	1932916.58	29.77	18275925.77	130
1917	726655.07	76929.69	1896365.07	73.40	16297375.45	137
1918	801537.94	90861.85	2092801.35	28.12	18540742.75	132
1919	965898.54	93529.06	2476118.48	21.69	21150767.88	138
1920	790167.55	76092.00	2108766.61	6.93	18776046.87	134
1921	568404.61	61553.62	1872207.18	7.54	18699525.49	132
1922	801245.97	68734.75	2383390.72	5.55	21599223.26	136
1923	838912.93	69084.11	2382660.41	12.69	21148824.59	136
1924	764340.71	52736.46	2078303.27	35.31	18284088.46	137
1925	886999.69	65703.07	3198378.34	30.40	33332549.59	136
1926	791510.89	52411.51	2321711.39	7.62	19358191.52	134
1927	740019.48	35208.05	2365927.66	37.47	19405975.91	118
1928	906953.92	36159.57	2711737.00	44.43	21602306.92	104

Table 1.A1: Summary Statistics, Imports and Exports, 1912-1928

Table 1.A1 reports summary statistics for positive aggregate trade flows (imports plus exports) between provinces and treaty ports from 1912 to 1928. All values are converted to 1907 USD. *N* denotes the number of province–port pairs with positive trade flows.

Year	Mean	Median	SD	Min	Max	N
1912	381311.79	35521.08	1098076.43	11.43	10478613.19	128
1913	462994.55	63349.25	1410651.28	68.15	13372535.78	124
1914	429216.75	48325.14	1332125.25	6.24	13133224.52	132
1915	400344.42	67365.56	1090458.65	10.87	9661455.52	132
1916	461045.42	53598.59	1295836.19	29.77	11384233.76	129
1917	542817.73	71550.64	1357296.05	73.40	11086282.59	135
1918	575651.04	76748.51	1391620.68	28.12	11224458.55	132
1919	705661.78	70832.50	1852649.65	21.69	16156825.41	137
1920	585180.57	63428.80	1525067.50	6.93	13609597.41	134
1921	503215.75	53565.47	1525682.66	7.54	14144461.56	131
1922	615595.00	55226.94	1829914.37	5.55	15202032.94	134
1923	623409.28	62855.86	1813947.54	12.69	16134431.08	135
1924	614657.22	50408.27	1729610.65	35.31	14401741.61	136
1925	732319.70	67741.28	2799030.16	30.40	29223601.24	134
1926	642154.55	50854.63	2037919.32	7.62	18354565.61	132
1927	564663.80	33484.70	1939709.30	37.47	18150511.02	117
1928	740989.07	34428.28	2383607.77	44.43	20875641.75	103

Table 1.A2: Summary Statistics, Imports Only, 1912-1928

Table 1.A2 reports summary statistics for positive import flows between provinces and treaty ports from 1912 to 1928. All values are converted to 1907 USD. *N* denotes the number of province–port pairs with positive import flows.

Table 1.A3: The Effects of Military Factions on Trade Between Provinces and Ports, All Pairs, 1912-1928

Dependent Variable:	log(Value+1)					
	Imports + Exports			Imports Only		
	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
Constant	23.79***			23.18***		
	(0.4127)			(0.4287)		
log(Distance+1)	-3.167***	-3.764***	-3.106***	-3.085***	-3.668***	-2.996***
	(0.0561)	(0.0800)	(0.0942)	(0.0586)	(0.0855)	(0.1007)
Diff_Faction	-0.4625***	-1.047***	-0.7391***	-0.4474***	-1.019***	-0.7045***
	(0.0946)	(0.1380)	(0.1289)	(0.0927)	(0.1388)	(0.1274)
River			0.4398**			0.3625**
			(0.1699)			(0.1712)
Railway			2.743***			2.824***
			(0.2218)			(0.2220)
Fixed-effects						
Port_Year		Yes	Yes		Yes	Yes
Province_Year		Yes	Yes		Yes	Yes
Fit statistics						
Observations	12,331	12,331	12,331	12,331	12,331	12,331
R^2	0.35707	0.57094	0.59292	0.35146	0.56237	0.58641
Within R^2		0.47885	0.50555		0.47026	0.49936

Note: This table reports regression results from the following equation: $\log(V_{ijt}) = \alpha_1 \log(Distance_{ij}) + \alpha_2 I_{ij}^{Railway} + \alpha_3 I_{ij}^{River} + \beta I_{ij}^{Diff\_Faction} + \gamma_{it} + \gamma_{jt} + \epsilon_{ijt}$. Regressions are estimated using the sample comprising all possible combinations of provinces and ports. These results remain consistent with the baseline findings, indicating that the baseline results are not driven by the way I construct the dataset.
Clustered (Province_Year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Data Description

- Trade flows between provinces and treaty ports: obtained from the **Inland Transit** section of the Chinese Maritime Customs (CMC) trade reports.
- Faction data: sourced from Sheridan (1983) and Jiang (2008).
- Distance data: calculated using the Haversine (great circle) formula based on geographic coordinates.
- River data: the following treaty ports are located along the Yangtze River: Chinkiang, Chungking, Hankow, Ichang, Kiukiang, Nanking, Shanghai, Shasi, Wuhu, Yochow, and Wanhsien. The following provinces are also situated along the Yangtze River: Szechwan, Yunnan, Hupeh, Hunan, Kiangsi, Anhwei, and Kiangsu.
- Railway data: The railway network is treated as fixed during the period 1912–1928. The following railways are included in the analysis: Jinpu Railway, Beining Railway, Huhangyong Railway, Zhegan Railway, Pinghan Railway, Daoqing Railway, Zhengtai Railway, South Manchuria Railway, Guangjiu Railway, Guangsan Railway, Jinghu Railway, Shen'an Railway, Nanxun Railway, Bianxu Railway, Yuehan Railway, Dianyue Railway, Jiaoji Railway, Chinese Eastern Railway.
- Commodity-level import and export data: obtained from the **Analysis of Foreign Trade** section in the CMC trade reports. For each commodity, the reports provide the quantity and value by country of origin (or destination) as well as by treaty port. Quantity data are missing for some commodities.

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Chapter 2

TRADE, INDUSTRIALIZATION, AND REGIONAL DISPARITIES

2.1 Introduction

For late-developing countries, industrialization can benefit from the collaborative efforts of government support (help "from above"), private initiatives (help "from below"), and foreign technology transfer (help "from abroad"). However, these three spurs to development are not always available. Many late-developing countries face problems of political turmoil and varying access to help from above, below, and abroad as they industrialize. China provides an important example of the issues involved. Its industrialization began to accelerate during the Warlord Era (1912-1928), a period of political instability following the collapse of the Qing Dynasty.[1] It remains a puzzle why and how industrialization took shape in the absence of a conducive political environment.

During the Warlord Era, China was fragmented into regions controlled by military governors, whom we would consider warlords. The central government lost most of its former economic power, while the short-lived local governments implemented little to no effective economic policy. Paradoxically, this era also witnessed China's first wave of large-scale industrialization, marked by the emergence of thousands of private industrial firms[2] all over the country. These firms combined domestic labor with foreign machinery, initiating China's first attempt at large-scale economic transformation into a modern, industrial economy.

In this paper, I demonstrate that market liberalization and foreign trade access together can explain China's industrialization during the Warlord Era. During most of the Qing Dynasty, the imperial government severely restricted private industrial enterprises. It was not until 1904 that the Qing government introduced China's first set of company laws, which signaled a change in the government's attitude towards private industrial enterprises. Following the liberalization of private industrial

[1]The Qing dynasty (1644-1912) was a Manchu-led imperial dynasty of China and the last imperial dynasty in Chinese history. After the Qing Dynasty came the Republican period of China (1912-1949).

[2]In this paper, industrial firms refer to mechanized firms and do not include handicraft shops that produce manufactured goods by hand.

initiatives, private industrial enterprises began to emerge under market forces. Given that markets in China were highly competitive, foreign trade access played a key role in shaping market prices, which, in turn, explained the spatial pattern of industrial firm entry.

Existing theories are inadequate to explain the acceleration of China's industrialization during the Warlord Era. In many late-developing countries, industrialization was driven by trade policies, namely import-substitution industrialization (ISI) and export-oriented industrialization (EOI). ISI typically involves implementing tariffs to protect nascent industries from foreign competition, while EOI focuses on encouraging the production of goods for export to the global market. Throughout the Warlord Era, China was compelled by previous treaties to maintain a tariff rate below 5%, which was lower than that of most major countries in the world, particularly South American countries, which were prominent examples of ISI.[3] Moreover, many new industrial firms did not target exports. For example, the matchstick industry experienced rapid growth during the Warlord Era. Despite the emergence of dozens of new domestic firms producing matches, no matches were exported until the very end of the period.[4] Neither ISI nor EOI explains China's case.

Moreover, the spatial distribution of new firms in China cannot be explained by domestic endowments. The location of new firms was only loosely correlated with domestic endowments considered important for industrialization. Consider two commonly-noted factors in the literature: agricultural households and coal production (e.g., Cameron, 1985). Agricultural households were a major source of unskilled labor supply; however, the correlation between firm entry and agricultural households in 1914 was only 0.34. One explanation is that, given China's large population, even the least populated provinces still had millions of households, making labor supply hardly a constraint. Coal was the main energy source for steam engines, yet the correlation between coal production and firm entry was only -0.03. As shown in this paper, provinces that were unable to produce coal themselves could still acquire it through foreign trade.[5]

Perhaps the spatial distribution of industrialization can be explained by China's treaty port cities. These cities could conceivably have pioneered China's industrialization, because the foreign powers had by treaty established extraterritorial

[3] Refer to Table 2.B1 for detailed tariff rates.

[4] See Figure 2.B1 for an overview of the matchstick industry.

[5] See Figure 2.B2 for a comparison of the spatial distribution of firm entry with agricultural households and coal production in 1914.

concessions within them that adopted advanced legal and financial institutions. The previous literature on China's industrialization has in fact focused on these treaty port cities. However, these port cities constituted less than 1% of China's territory and population. Clearly, their development could not represent the country as a whole. Furthermore, during the Warlord Era, half of the new firms were established outside of treaty ports, with some located far from these ports. It is worth investigating the entry of these firms, especially as they did not benefit from the advanced institutions in treaty port cities.

I argue that China's industrialization followed a market-driven process, with private participants making entry decisions based on market prices determined by foreign trade access. To explain how foreign trade access influenced industrial firm entry, I first develop a firm entry model within a competitive market in an open economy. Different types of imports have distinct effects: imported consumer goods compete with local production, potentially suppressing the development of the domestic industrial sector, while imported capital goods provide essential production materials that are otherwise unavailable. In a competitive market, the arrival prices of imports determine the market prices in equilibrium. Better access to foreign consumer goods, that is, lower arrival prices of foreign consumer goods, leads to lower market prices of consumer goods, which decreases the revenue of local producers and thereby discourages firm entry. Conversely, better access to foreign capital goods reduces the market prices of capital goods, lowering production costs for domestic producers and encouraging firm entry.

The variations in regional firm entry were driven by differences in the arrival prices of imports. For each province, the arrival prices of imports were jointly determined by the global prices and the internal trade costs. The global prices affected all the provinces in the same way. Therefore, internal trade costs played a key role in explaining spatial variations in foreign trade access within China. The internal trade costs themselves have two components: one is the physical transport costs, and the other involves the institutions of foreign trade in China. Foreign trade was governed by the Treaty Port system. This system required all the imports and exports to transit through one of fifty custom stations (treaty ports). Provinces had to "trade" with these ports to obtain foreign goods. This kind of province-port trade naturally incurred significant internal trade costs due to China's vast geography and underdeveloped modern transportation. During the Warlord Era, China was divided into regions controlled by warlords. Tensions among them also affected these costs.

Additionally, because different ports traded different commodities depending on the origin countries they were associated with, a province's access to consumer goods differed from its access to capital goods. These internal trade costs crucially influenced the arrival prices of foreign goods that affected firm entry decisions.

Exploiting newly-digitized trade data from the Chinese Maritime Customs (CMC), I examine this mechanism empirically at the provincial level. The Chinese Maritime Customs was in charge of collecting trade duties at treaty ports and therefore kept high-quality records on imports and exports. My first trade dataset contains the annual value of trade between provinces and ports. This dataset details the transits of foreign goods within the country, which has so far not been used in the literature. My second trade dataset contains the annual commodity-level imports and exports at each treaty port. This dataset allows me to identify differences in commodity availability and prices across treaty ports, as well as to distinguish between imports of consumer goods and capital goods.

Combining these two trade datasets, I create an innovative index of foreign trade access — the expected arrival price of foreign goods. This index serves as an empirical estimate of the arrival price in the model. However, to clarify, this index is not the literal price calculated from the prices of foreign goods that actually arrived in a region. Rather, it is a novel measure of a region's foreign trade access, representing the expectations about prices domestic producers formed when making entry decisions. The index draws inspiration from both the "market access" approach (e.g., Donaldson and Hornbeck, 2016) and the "price index" used to measure market competitiveness in trade theory (e.g., Junz and Rhomberg, 1973). Furthermore, this index effectively incorporates shocks created by global political events (e.g., WWI) and domestic warlord politics (i.e., military alliance), which introduced significant exogenous variations in foreign trade access across regions and years. I estimate an expected arrival price of foreign consumer goods and an expected arrival price of foreign capital goods each year for each province.

I then link the expected arrival prices to industrial firm entry at the provincial level. The baseline approach is the two-way fixed effects ordinary least squares (OLS). The empirical results confirm the prediction of the model: a 1% increase in the expected arrival price of foreign consumer goods increased industrial firm entry by 2.7%, whereas a 1% increase in the expected capital goods price decreased industrial firm entry by 1.5%. The results are robust to different regression models. A series of robustness checks yield consistent results. To further address the potential endogeneity problems, I employ an innovative instrumental variable design that leverages the unique historical context of warlordism. This IV regression also provides consistent estimates.

My empirical results confirm the market-driven mechanism of industrialization and highlight the role of foreign trade access in regional economic transformation. The findings show the opposing effects of trade access to foreign consumer goods and foreign capital goods on regional industrial development. Moreover, they demonstrate that liberalized markets alone were able to induce some industrialization as private participants responded to market forces. These findings have significant implications: if the Qing government had lifted entry restrictions on private industrial enterprises earlier, bottom-up industrialization could have taken shape earlier.

This study contributes to an extensive literature on the historical processes of economic development. A first strand involves the drivers of industrialization, especially for late-developing countries. Many existing studies highlight government-related factors, such as public infrastructure (e.g., Tang, 2014), legal institutions (e.g., Gregg, 2020), and knowledge codification (e.g., Juhász, Sakabe, and Weinstein, 2024). Even during periods of political instability, governments could still promote industrial development by selectively enforcing property rights (Haber, Maurer, and Razo, 2003). This study is unique in that it demonstrates that some industrialization can occur in the absence of government support. The liberalized market was capable of inducing industrialization even in the absence of much government support.

A second strand involves the historical impact of foreign trade on local economic development. Recent studies focus on advanced industrial economies (Chan, 2025; Jaworski and Keay, 2022). They find that increased foreign trade exposure encouraged local manufacturers by opening up world markets for their industrial products. This study enriches the understanding of foreign trade by focusing on a late-developing country. In this case, foreign trade, in particular imports, served both as a means of technology transfer and as a competitor to domestic producers. Exports were less important as the manufactured products of later-developing countries might be less competitive in the global markets. The linkage between foreign trade access and regional economic development for countries undergoing industrialization is therefore different from the one for industrialized economies. The findings in this paper suggest that improved foreign trade access might not necessarily promote regional industrial development, as better access led to lower prices of both foreign capital goods and foreign consumer goods, which have opposing effects.

Many economists have taken an interest in China because of its rich history and its current economic importance, but the Warlord Era still remains understudied. The Warlord Era was an important transitional period in terms of both politics and economics. Many subsequent events in 1930s and 1940s can be traced back to this period. Rawski (1989) points out that China's economy saw significant economic growth during the Warlord Era. He recognizes the expansion of the private sector during this period and the importance of foreign trade in China's economic development. While his book is inspiring, it is highly descriptive and lacks systematic analysis. There is thus a gap in our understanding of the interconnections of these economic activities and how they contributed to China's economic transformation. This paper fills that gap by providing a quantitative analysis of economic activity at the provincial level.

This paper proceeds as follows. Section 2.2 introduces the historical context of China's industrialization from 1840 to 1940. Section 2.3 first introduces foreign trade practices worldwide and then discusses the role of foreign trade specific to China. Section 2.2 and Section 2.3, although longer than typical, provide important background knowledge for understanding the findings. Section 2.4 describes the data on foreign trade and firm activity. Section 2.5 develops a firm entry model in an open economy. Section 2.6 tests the predictions from the model and reports the results. Section 2.7 expands the discussion and suggests directions for future research.

2.2 China's Politics, Foreign Trade, and Industrialization (1840-1930)

2.2.1 An Overview

Industrialization became a matter of policy debate after China's defeat in the First Opium War. From 1850 to 1930, China began to industrialize despite significant social, economic, and political challenges (e.g., the Taiping rebellion (1850-1864), the Second Opium War (1856-1860), the First Sino-Japanese War (1894-1895), the end of the Qing (1911)). China's industrialization began in the second half of the eighteenth century with a government-led path centered on heavy industry. The state strictly controlled machinery imports and limited private industrial initiatives. Between 1904 and 1907, the Qing government introduced a series of institutional reforms, notably the 1904 Company Law, which finally liberalized private industrial initiatives. From this point, China began to shift toward a market-driven economy. During the government-led phase, industrialization centered on military needs and was constrained by conservative political institutions. Following the weakening of the Qing government, especially during the Warlord Era, a period of national disintegration, market incentives replaced government control in directing investment. Because of the domestic upheavals, China's industrialization during the Warlord Era is often overlooked. China's economy was competitive, open, and fragmented in a way that was unprecedented and unlikely to be seen again, yet it displayed at least modest structural transformations (Rawski, 1989).

The Warlord Era, the focus of this study, was the first wave of *large-scale* industrialization in China. During this period, thousands of private industrial firms emerged in an open, competitive, and fractured economy. China was forced by previous treaties to maintain exceptionally low tariff rates. Barriers to entry were largely absent, as were limits on machinery and other capital goods imports, so markets were highly competitive. The economy was also fractured by high internal trade costs. China's vast geography, underdeveloped modern transportation, and political disintegration separated provinces into relatively independent markets.

During the Warlord Era, industrialization was dominated by imports-substitution. Yet, this does not mean that exports did not exist. Chinese products, in particular tea, silk, and ceramics, had already been popular in many other countries for centuries. In the late 19th century, machines were introduced into the manufacturing processes of these products to accommodate the increasing demand in the global market.[6] However, Chinese specialties were just a few products that were produced in some specific areas using particular skills. Before 1928, exports remained concentrated on agricultural goods and traditional handicrafts. They could not bring about a large-scale economic transformation. Instead, most factories were established to substitute imported consumer goods with local production for the domestic market. This paper therefore focuses on imports and its role in China's industrialization.

China's experience diverged from the classic import-substitution industrialization (ISI) theory. In the traditional ISI framework, the government actively raises tariffs to protect emerging domestic industries. However, during the Warlord Era, the Chinese government lacked the capacity to implement effective policies to shield domestic producers, as it had limited control over local regions and no authority over customs due to prior treaties. I demonstrate that China's industrialization followed a market-driven path. The key driver of this industrialization process was the relative price of consumer goods and capital goods. In other words, the driver of this process

[6] *The Cambridge History of China*, Volume II, Page 132-133.

arose from the market, not government intervention, leading to differing levels of outcomes as market conditions varied significantly across provinces.

2.2.2 The First Opium War (1839-1842) and The Forced Opening of China (1840-1940)

China had been the dominant power in Asia for hundreds of years until the First Opium War (1839-1842), when the British army demonstrated the power of new technologies. The tensions between China and Britain stemmed from enduring differences in political economy, in particular foreign trade. When China and Britain first began to trade, the Qing government imposed trade restrictions that limited foreigners' access to Chinese markets and its own subjects' access to foreign technologies. Britain and other countries had large trade deficits with China that they settled in silver. To correct this imbalance, Britain began to sell Indian opium in China, which led to widespread addiction and severe health problems. The Qing government sought to prohibit the opium trade. In 1839, Lin Zexu, the Chinese official tasked with eradicating the opium trade, seized a large amount of opium from foreign traders and destroyed them at Humen to show the government's commitment to ending the trade. The destruction of opium at Humen heightened tensions between China and Britain, leading up to the eventual outbreak of the First Opium War. China lost the war unsurprisingly due its technological and military inferiority.

After the First Opium War, China and Britain signed the Treaty of Nanking, in which China was forced to open five ports—Shanghai, Ningpo (Ningbo), Canton (Guangzhou), Amoy (Xiamen), and Foochow (Fuzhou)—to foreign trade. These ports became so-called "treaty ports." In the following decades, the Qing government signed more treaties with countries including the Britain, the US, France, Germany, and Russia. By 1910, about 50 treaty ports had been established in China, as shown in Figure 2.1, and they continued to operate until the 1940s. Although the Treaty Port system resulted from military defeats, it became one of the most important economic institutions that accelerated China's economic transformation.

Treaty ports served as the exclusive entry and exit points for foreign trade. All the imports and exports had to go through these designated ports. China mostly had flat tariff rates that were less than 5% until 1929 when the Chinese government regained the capacity to set tariffs (Bo, Chen, and Liu, 2022). The Chinese Maritime Customs Service (CMC) monitored trade and collected trade duties. Founded in Shanghai

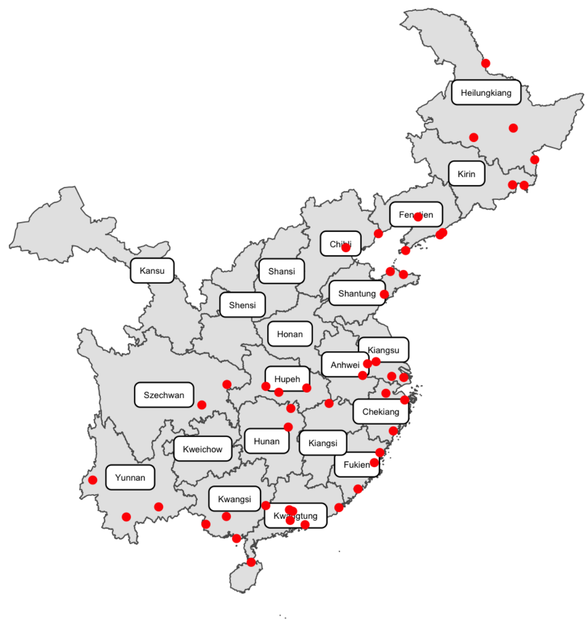


Figure 2.1: A Map of the Treaty Port System
Source: the CMC trade reports. See Section 2.4 for details. Red dots represent treaty ports. Only treaty ports actively engaged in foreign trade are plotted. Labels represent provinces in China.

by foreign consuls in 1854, the CMC was primarily responsible for ensuring the efficient and transparent collection and management of customs duties so that the Qing Dynasty and later the Republic of China could meet the financial obligations imposed by the indemnity mandated by treaties (Keller, Li, and Shiue, 2011). It established stations in most treaty ports. The CMC was operated under the management of foreign powers, with its staff coming from various foreign countries into the 1930s. For the Chinese government, even though the CMC marked a loss of sovereignty, it played a crucial role in stabilizing China's finances. The CMC restricted the ability of local Chinese government officials to withhold trade revenues, providing a reliable source of income for the central government.Ma (2019) argues that the CMC was the first modern and independent civil and tax bureaucracy. The CMC broadened its scope over time to include anti-smuggling efforts, postal administration, coastal policing, harbor and waterway management, and weather reporting (Keller, Li, and Shiue, 2011). The CMC was particularly important during the period of national disintegration following the collapse of the Qing Dynasty, because it ensured the continued smooth operation of foreign trade.

Treaty ports cities benefited most from the system. They were unarguably the pioneers in China's modernization. Although China retained formal sovereignty over treaty port cities, Chinese authority was limited by international agreements that set up foreign concessions. In these concessions, foreign countries used their own legal systems, police forces, and administration, creating institutional environments distinct from those in the other parts of China. Keller and Shiue (2022) find that foreign institutions brought by treaty ports substantially lowered regional interest rates because the concession courts were efficient at enforcing contracts. Treaty port cities enjoyed higher growth while they were treaty ports, and the effects persisted after China's reopening in the 1970s (Jia, 2014; Liu and Zhang, 2023). However, it is important to note that these treaty port cities constitute less than 1% of China's territory and population. They were simply too small to drive the entire country's development. Regions outside the treaty port cities saw limited benefits from the advanced institutions established in those ports, but the Treaty Port system still mattered to the rest of country because it provided access to foreign goods.

2.2.3 The Self-Strengthening Movement (1861-1895) and the Collapse of Qing (1911)

The Self-Strengthening Movement (1861–1895) is often viewed as the starting point of China's industrialization. The Qing government started this effort after a series of military defeats. Its aim was to strengthen the nation by adopting Western technology and knowledge. The priority of the movement was to modernize the Chinese army. A few state-owned enterprises, mainly in the defense-related industries, were established, including the Jiangnan Arsenal (1865) and the Tianjin Arsenal (1867). These factories, which used imported machinery and raw materials and employed foreign engineers, were the first mechanized factories in China. At the same time, the bureaucracy sought to improve human capital by sending Chinese students to study in Europe and America.

However, the Self-Strengthening Movement was not enough to start general industrialization. Resources were tilted towards heavy industry and military equipment. The civilian sectors and non-military programs received little attention and investment. Private industrial initiatives were severely restricted and had little autonomy in terms of capital imports. Moreover, all the industrial enterprises under the movement were supervised by the government. In fact, the Qing government never aimed at full-scale industrialization. It wanted to bolster the traditional economy and institutions and feared the potential loss of power that could result from extensive modernization. The lack of private initiatives hindered the development of domestic markets. China did not experience substantial industrialization in terms of the number of factories and their output during this period (Goetzmann and Koll, 2005). Even in the primary goal of military modernization, China only achieved limited success. The movement ultimately ended in gloom after China's defeat in the First Sino-Japanese War in 1895.

Defeat in the First Sino-Japanese War foreshadowed the downfall of the Qing. The Boxer Rebellion and the intervention of the Eight-Nation Alliance between 1899-1901 further destabilized the country and diminished the central authority. Finally, the Hsinhai Revolution was ignited in 1911 in Wuchang. Yuan Shih-kai, the most powerful military leader in the Qing government, agreed to support the revolution on the condition that he would lead the new government. Yuan successfully convinced the last emperor of Qing to abdicate, which marked the end of over two millennia of imperial rule in China.

2.2.4 The Warlord Era (1912-1926)

The Hsinhai Revolution (Oct 10, 1911-Feb 12, 1912) ended the Qing dynasty and the Republic of China was established, with Yuan Shih-kai as the first president. Although the transition occurred without much violence, the Republic could not bring stability. Three years later, in 1915, Yuan Shih-kai attempted to restore the hereditary monarchy by appointing himself emperor. Yuan Shih-kai's about-face alienated many of the Republic supporters and China split into regions under the control of local military leaders (the warlords). The period of fragmentation began in 1916 following Yuan Shih-kai's death and lasted until 1928 when the Kuomintang under Chiang Kai-shek reunified the country. The warlords competed for power and resources, regularly putting troops into the field. Appendix 2.A offers a brief overview of warlordism and its economic effects. For a more detailed analysis, see Feng (2025).

Despite the political instability that started in the 1890s and continued past 1928, industrialization started to accelerate during the final years of the Qing Dynasty and continued throughout the Warlord Era. Throughout most of the Qing Dynasty, the imperial government restricted private enterprises from engaging in industrial production (Goetzmann and Koll, 2005). In 1904, the Qing government introduced China's Company Law, signaling a shift in its attitude toward private business and setting the stage for bottom-up industrialization.[7] The fall of the central government further weakened the traditional political institutions that had long blocked modernization (Rawski, 1989). Unlike the former government-led economy, China's economy saw rapid growth in the private sector during this period. Rawski (1989) argues that *domestic, private, civilian, and competitive* were the four key concepts of China's economy during the Warlord Era. Private enterprises in the consumer goods industry were founded in great numbers (Goetzmann and Koll, 2005). Funded by indigenous Chinese capital, these firms were often small and operated in highly competitive markets. These firms brought about fundamental changes to China's economy. Between 1912-1936, the annual average growth rate of mining and manufacturing was 9.4%, which was higher than Japan's 6.6% and UK's 4.4%; factory production grew by 8.1%, which was slightly lower than Japan's 8.8% but much higher than US's 2.8%.[8] Although the China figures should be interpreted with caution since China started from a low baseline, they nevertheless show that the Chinese economy began to undergo structural change. Certainly the rate of change is far beyond what occurred under the Qing.

Despite the overall progress in industrial development, it is important to recognize that this growth was unevenly distributed, across industries and regions. Most new firms were in the consumer goods industries. Even in 1935, China was still unable to produce most capital goods. In 1933, Chinese production of cotton yarn was already 79% of that of Japan, and flour was 159%. However, when it came to steel, Chinese output only 1% of Japan's. The ratios for cement (19%) and sulfuric acid (3%) were also tiny.[9] Moreover, growth varied significantly across regions. Based on Ma (2008)'s calculation, the per capita income in the Lower Yangzi (near Shanghai) was 55 percent higher than China's average. While the region experienced structural changes comparable to Japan during the Warlord Era, it follows that much of the rest of the country experienced less change. Chinese manufacturing output in 1933 was 2645.5 million yuan. However, 39.7% of all output was produced in the Shanghai region and 14.2% in Manchuria.[10] Rawski (1989) concludes that Chinese industrialization was primarily a regional phenomenon. This paper exploits the spatial

[7] Kirby (1995) argues that the objectives of the Qing government were economic development and the restoration of economic sovereignty, which together sought to reinforce the power of the central government. It sought to encourage the establishment of Chinese companies to compete with foreign producers in the domestic market and justified the demands for abolishing extraterritoriality through legal reforms.

[8] *Economic Growth in Prewar China*, Page 70.

[9] *Economic Growth in Prewar China*, Page 75.

[10] *Economic Growth in Prewar China*, Page 74.

distribution of industrial firm entry to develop a mechanism of industrialization that in turn explains the observed regional disparities.

2.2.5 The Northern Expedition (1928-1928) and The Japanese Invasion (1931-1945)

In 1926, the Kuomintang (KMT) launched the Northern Expedition, a military campaign to reunify China. Starting in two provinces in southern China, Kwangtung (Guangdong) and Kwangsi (Guangxi), the National Revolutionary Army, led by Chiang Kai-shek, gradually gained controlled of the rest of the country. The Northern Expedition concluded successfully in December 1928 when Chang Hsueh-Liang, the warlord who controlled Manchuria, accepted the authority of the Nationalist government in Nanking (Nanjing). However, the reunification did not restore the central government's authority to what it had been under the Qing. The new national government faced both domestic tensions and international pressures. Internally, although warlords all purported to accept the authority of the Nanking government, many of them still retained extensive autonomy in their regions and control of their armies. Externally, the threat from Japan continued to grow. Japan took over Manchuria in 1931, and then launched a full-scale invasion in 1937. The invasion of Japan marked the end of China's first wave of industrialization. During the Second Sino-Japanese War, the Nationalist Party attempted to implement a "national defense economy," but the warfare caused massive damage.

After the Japanese surrendered in 1945, a civil war between the KMT and the CCP broke out. The civil war was eventually won by the CCP in 1949 and Chiang Kai-shek fled to Taiwan. The CCP adopted a centrally planned economy with strict control over foreign trade and a focus on heavy industry. It was not until the Deng Xiaoping reforms in 1978 that China returned to trade and consumer goods industry.

2.3 Foreign Trade and Growth

Foreign trade is a key force in economic and social development even before industrialization. Acemoglu, Johnson, and Robinson (2005) argues that growth of the Atlantic trade provided the merchant groups with substantial profits and political power that allowed them to induce institutional changes, which were central to the rise of Western Europe after 1500. Trade was even more important during the Industrial Revolution because key raw materials (e.g., raw cotton and iron ore) had to be procured at long distances. More generally, the Industrial Revolution in the late eighteenth century was closely connected with global trade and oversea market expansions (Findlay and O'rourke, 2009). Global trade provided the sources of raw materials and markets for manufactured products for countries first to industrialize, which sustained the growth brought about by the technological change. Following the Industrial Revolution (1760-1840), the intensity of global trade continued to increase, which finally led to the so-called the First Wave of Globalization (1870-1914) during the fifty years before WWI. This period saw a worldwide convergence of commodity prices, primarily due to advancements in transport technologies that reduced transportation costs. The unprecedented integration of international markets broke down during the Great War (1914-1918) and the Great Depression (1929-1939).

China had long been a part of global commodity trade, absorbing large fractions of New World silver by exporting tea, silk, and luxury handicrafts. However, the Chinese emperors imposed strict restrictions on foreign interactions, limiting the extent of trade behavior and technological exchange. The turning point in China's foreign trade came in the 1840s when Western powers forced China to liberalize its commodity trade following its military failure in the First Opium War (1839-1842). The liberalization of trade was not immediately accompanied by the deployment of Western technologies. A small range of Western technologies, mainly military, were brought into China under government supervision after 1860. However, the large-scale application of Western technologies did not begin until the start of the twentieth century, more than half a century after China's trade liberalization.

In terms of trade policies, different countries chose different paths.[11] Before the Industrial Revolution, most Western European countries (e.g., Britain and France) adopted mercantilist trade restrictions. Their policies sought a positive trade balance to protect the wealth of the nation. In the nineteenth century, many European countries began to liberalize trade, following Adam Smith's advocacy of free trade and open markets. However, after 1870 the trend reversed, and protectionism began to rise in many countries to protect domestic interests (Kindleberger, 1975), such as France and Germany. An exception is that the British Empire, which had very low tariffs until 1914. In the United States, native manufacturers sought protection from European competition and thus kept tariffs at high levels through lobbying. In Latin America, tariffs rose after independence primarily to raise government revenue (Irwin, 2002).

However, the picture was different in China. Tariffs were not set by the Emperor. Instead, they were derived from treaties with Western countries following China's

[11] See *Power and Plenty*, Chapter 7, for detailed narratives.

military defeats in the nineteenth century. Western powers imposed nearly free trade policies on China, with customs duties below 5%. These treaties remained in effect even after 1900, when most countries turned to higher tariffs. China did not regain customs autonomy until 1929. In 1913, the average tariff on manufactured imports was 20% in France, 13% in Germany, 44% in the United States, and 28% in Argentina. Britain had no tariff at that time. In 1925, the tariff was 21% in France, 20% in Germany, and even Britain had implemented a 5% tariff. The US and Argentina maintained high tariffs of 37% and 29% respectively. However, throughout the first three decades of the twentieth century, China adhered to the treaties and had tariffs below 5%, much lower than almost all the countries.[12]

The prevailing view holds that global trade during the First Wave of Globalization exhibited increasing specialization, in which countries traded based on their comparative advantages (Findlay and O'rourke, 2009). Leading industrial countries specialized in manufacturing and exported high-value-added manufactured goods to late-developing countries in exchange for primary products. This view captures much of the commodity flows during the nineteenth century. In 1913, Britain and Northwestern Europe were the predominant net exporters of manufactured goods, while Asia and other continents were the net exporters of raw materials.[13]

However, this view fails to account for the efforts made by late-developing countries on industrialization. For example, Japan successfully adopted Western technologies and turned into a major exporter by the eve of WWI (Meissner and Tang, 2018). For China, its nationwide industrialization started later than in Japan; however, there was still a substantial surge in native production between 1910 and 1930. From the outcomes, China did not become a major exporter of manufactured goods like Japan. China still mainly exported Chinese specialties like tea and silk or raw materials such as animal skins and ores (Keller, Li, and Shiue, 2011). China's industrialization followed a path different from Japan and many early-industrializing countries. Because of its relatively small domestic market, Japan chose to place its products in low-income overseas markets to sustain its industrialization. China, on the other hand, had a huge domestic market that allowed many domestic producers to enter the market without aiming for exports. Between 1910 and 1930, there was a decline in the imports of consumer goods such as matches and textile products in many regions, where imports were increasingly being replaced by local production (Keller, Li, and Shiue, 2011; Du, 1991).

[12] *Power and Plenty*, Page 403 and Page 444

[13] *Power and Plenty*, Page 412

Given China's lack of tariff autonomy, the increase in firm activity during this period cannot be explained by protectionist trade policies. The weakening of the central government also implied that it could not deploy subsidies to incentivize local producers. Nevertheless, China still began to industrialize under market forces during the Warlord Era. During that time, prices in the local markets reflected not only the prices of imports in the global market but also the internal trade costs to acquire them. Domestic trade was not friction-less in China (Keller, Santiago, and Shiue, 2017). China's vast geographic size, underdeveloped modern transportation, and political instability together created significant barriers to the transit of foreign goods within the country. The non-negligible internal trade costs encouraged the entry of industrial firms in some, but not all, regions.

Meanwhile, for China, the role of imports as a major means of technology transfer should not be overlooked. Despite the efforts made by the late Qing government to accumulate human capital, China made little progress in knowledge and skills transfer in the late nineteenth century. Few Chinese students who studied abroad returned to take positions in manufacturing.[14] After 1910, the decline of the central government made it difficult to further direct the adoption of new technologies. The political instability during the Warlord Era heightened the risks associated with long-term investment, which was typically required for the manufacturing of advanced capital goods. As a result, Chinese manufacturing during the first twentieth century relied largely on imported capital goods (e.g., Liu, 2020; Grove and Kubo, 2022). Therefore, different types of imports had different effects: imported consumer goods competed with local producers, while imported capital goods supported local producers.

Because of China size and high transport costs, the role of imports in China's industrialization should be examined at regional-level, rather than national-level. As previously mentioned, trade costs within China significantly impacted the arrival prices of consumer and capital goods across regions. Furthermore, due to the structure of the Treaty Port system, the arrival prices of consumer goods and capital goods might not change proportionally. Consequently, different regions experienced varying "internal tariffs" that could either protect or harm local producers. The effects of imports were localized and led to different levels of industrial growth across regions.

[14] *The Cambridge Economic History of China*, Volume II, Page 129.

2.4 Data

2.4.1 Trade Data

The main trade dataset I collected comes from the Chinese Maritime Customs (CMC)'s trade reports. The CMC was founded in 1854 in Shanghai by foreign consuls to ensure that China would pay indemnities owed after military defeats during the late Qing. It would continue in this role to WWII. The CMC collected all international trade taxes and paid China's international creditors first and then remitted the balance to Beijing. Over time, it established stations in all major treaty ports. As part of its operations, The CMC collected and published trade data on the value and quantity of imports, exports, re-exports, inland transit, and other categories for each treaty port. The quality of the data is usually considered to be high since top CMC employees were highly skilled graduates of universities such as Cambridge, Harvard, and Yale, who were accountable to both bondholders and the Chinese treasury (Keller, Li, and Shiue, 2011).

The first part of my trade dataset contains province-port trade data for each year between 1907-1928 from the **Inland Transit** section in the CMC trade reports. My dataset documents the value of foreign goods (imports) passed between each treaty port- province pair under the Transit Pass system[15] during each year. Merchants in Chinese provinces, as I have noted, traded with different treaty ports to acquire foreign goods. In this paper, I use "foreign trade" and "imports" interchangeably to refer to this type of trade. A limitation of the data is the reports do not detail the value or volumes of trade for individual commodities. All I could find is the total value of trade from each port to each province. Still, my province-port trade data indicates the destination of foreign goods (i.e., where foreign goods were consumed), which is not commonly found in the literature. Moreover, the lack of commodity details is addressed by the second part of my trade data.

A second trade dataset comprises the annual port-level commodity imports from the **Analysis of Foreign Trade** section in CMC trade reports. This dataset provides the quantity and the value of each commodity imported annually for each treaty port from 1904 to 1926. This second source allows me to observe the significant heterogeneities in commodities among ports, especially in terms of variety. It also

[15]The system of transit passes was initially created to give foreign merchants the option of either paying all internal taxes as the were levied by local officials, or instead receiving an exemption from all further taxes by paying the Maritime Customs a fifty-percent surcharge on the regular customs duties. Chinese merchants were included after 1876. Transit passes could be purchased for both foreign imports shipping to inland areas and inland goods being shipped to treaty ports. There were controversies regarding the implementation of policies. See Matthews (1999) and Brown (1978).

allows me to calculate commodity prices at each port. However, as mentioned, each port engaged in trade with multiple provinces, so this port-level dataset does not explicitly reveal the composition of trade for a specific province-port pair. Nevertheless, it still provides valuable clues to the commodities that provinces could buy from each port.

2.4.2 Firm Data

The firm data is collected from Du (1991).[16] It covers industrial firms established between 1858 and 1927 all over China. For each firm, it provides the name, start date, location, founder, ownership, industry, and initial capital.[17] This dataset is regarded as a highly complete collection of modern firms[18] in China and has been used in recent papers (e.g., Ma, 2024). One limitation is that the dataset does not contain firms' the exit dates. Nevertheless, I can study the entry of new firms, an essential part of regional industrialization.

In total, $3,533$ firms were established between 1870 and 1927, and $1,716$ of them were located outside treaty port cities. During my sample period (1908-1926), $2,643$ firms were established and almost half, $1,318$ of them were outside of treaty port cities. Table 2.1 shows that some were located far from the nearest treaty port. Among the $1,318$ firms, 265 were in the tertiary industry, while the remainder belonged to the secondary industry.[19] This paper focuses on the secondary sector (i.e., industrial firms). Foreign trade had the strongest impact on industrial firms because they relied on imported capital goods for production, and their outputs competed with imported consumer goods. The opposing effects of trade access to foreign consumer goods and foreign capital goods on industrial firm entry are elaborated upon previously in Section 2.3.

[16]Du (1991) synthesized data from various sources, including but not limited to Chinese government reports (e.g., *The Statistics of the Ministry of Agriculture, Industry, and Commerce* (农商统计表)), foreign government reports (e.g., *Overview of Chinese Industry* (支那工業総覧)), newspapers (e.g., *Journal of the General Chamber of Commerce of Shanghai* (上海总商会月报)), and local gazetteers (e.g., *Jiangsu Provincial Yearbook* (江苏省年鉴)). Although the Qing government introduced incorporation in the 1904 Company Law, many firms did not incorporate. Regarding firm registration, see Kirby (1995). This dataset includes both registered and unregistered firms.

[17]I remove a small number of firms without a clear start date.

[18]This dataset does not contain handicraft shops.

[19]The primary industry include agriculture and fisheries. The secondary industry includes mining, manufacturing, utilities, and construction. The tertiary industry includes shipping, maintenance, and finance.

Dist to Nearest Port	= 0	≤ 100 km	100-300 km	300-500 km	> 500 km
Count	1325	523	526	117	19

Table 2.1: Firm Entry 1908-1926
Source: Firm entry data are from Du (1991). Please see Section 2.4 for details. Distance is calculated using geographic coordinates. Firms with multiple locations or without a detailed location that can be used for retrieving geographic coordinates were excluded.

My firm data confirms Rawski (1989)'s view that China's economy was characterized by *private* and *civilian* initiatives. Among the $1,318$ firms founded during my sample period, $1,149$ of them were private. Private businesses dominated the economy. Most of these private enterprises were concentrated in the consumer goods industry, such as food processing, textiles, and convenience goods. For example, during my sample period, 80 match factories were established across China.

Despite the overall growth of the private sector, the distribution of new firms varied significantly across provinces as shown in Figure 2.2. Among the 19 provinces,[20] Chihli (Zhili, later Hebei), Kiangsu (Jiangsu), and Manchuria (Dongsansheng) accounted for the largest shares of new entrants. Kwangsi (Guangxi), Kweichow (Guizhou), Shensi (Shaanxi), and Kansu (Gansu) received fewer than 30 new entrants.[21]

Although the Chinese Merchants Stock and Commodity Exchange opened in 1920, the domestic stock market was still used little by private firms to raise funds (McElderry, 2001). A firm's capital was primarily raised through the personal connections of the founder(s) (Du, 1991). There is a lack of records on the sources of funding for most firms; however, archival research on the founders suggests that there was at least some degree of capital mobility. Some founders were able to access national capital (through private connections) and invested it in profitable markets. Appendix 2.B.2 provides details on founders in Shantung (Shandong) and Honan (Henan) to support this.

Summary

The province-port trade data range from 1907 to 1928 and the port-level commodity imports data range from 1904 to 1926. The data on firm activity begins in 1858

[20] I merge Heilungkiang (Heilongjiang), Kirin (Jilin), and Fengtien (Liaoning) to Manchuria (Dongsansheng).

[21] No province was left without firm entry.

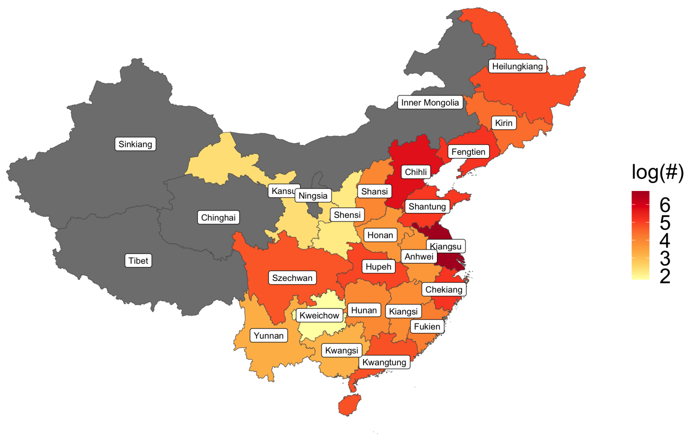


Figure 2.2: Distribution of New Firms, 1908-1926
Source: firm data are from Du (1991). Please see Section 2.4 for details. Dark areas are excluded from this study due to a lack of records.

and ends in 1927. My sample period, 1908-1926, is, therefore, the intersection of these three sources of data.[22] It covers the final years of the Qing dynasty (after the institutional changes that liberalized the private initiatives) and the whole Warlord Era except the last two years. The last two years (1927-1928) of the Warlord Era were marked by the Northern Expedition, a nationwide military campaign launched by the KMT that differed from the earlier low-casualty civil wars.[23] I therefore exclude these two years.

2.5 Modeling the Decision to Enter the Market

To guide the empirical analysis, I present a simple static model that frames a firm's entry decision. The model considers an entrepreneur[24] who is considering entering a specific consumer goods market. The entrepreneur decides only whether to enter the market or not. The assumption makes it easier to parse the role of foreign trade in entry decisions.

The model assumes that the firm is a price-taker in all the markets: the price of consumer goods it will produce (PC), the price of capital goods it might purchase

[22] As shown in Section 2.6, the calculation of the arrival prices uses the lag of province-port trade value. The arrival prices therefore are only available starting 1908.

[23] Most civil wars before the Northern Expedition were small in scale and low in causalities. Warlords were lack of modern weapons and modern communication devices. Their armies were not well-trained and hardly modernized. They were not able to cause massive destruction (Rawski, 1989; Ch'i, 1976).

[24] In this paper, I use "prospective entrepreneurs" and "prospective firms" interchangeably.

(PK), and labor (w). The firm uses capital goods and labor to produce consumer goods, which it sells in the market at the market price. This is an assumption commonly used in the literature (e.g., Gregg, 2020). The assumption has two implications. First, this assumption suggests that the market is highly competitive and the firm has little market power. This assumption is justified by the historical setting. Markets during the sample period were dominated by small and private firms and were highly competitive (Rawski, 1989). This assumption suggests that the supply of consumer goods, the supply of capital goods, and the supply of labor are all perfectly elastic. As long as each firm has little market power, this is reasonable. At current market prices, foreign trade can easily supply additional units consumer goods and capital goods. At the given wage, more workers are willing to work for the firm, but if it cuts the wage, its labor force will go elsewhere. In the empirical analysis, I relax these conditions and consider the potential endogeneity problems associated with them.

The model assumes that every province imports every consumer good. If we had sufficiently disaggregated data, this assumption would surely fail for some goods. Yet, the trade data and numerous qualitative evidence show that imports were quite widespread. The existence of imported consumer goods implies that the market price of consumer goods (PC) is determined by the price of imported consumer goods in equilibrium. Figure 2.3 visualizes the consumer goods market. The intersection (O) of the local supply curve (S) and the local demand (D) is the market equilibrium in absence of imports. When imported consumer goods (IM) arrive, they drive the market to a new equilibrium (E) at a lower price (PC). I further assume that at a certain price, consumers always prefer locally produced goods. Therefore, if the firm chooses to enter the market, it shifts the local supply curve from S to S' and the market equilibrium from E to E'. However, no firm is able to drive out all the imports, so the market price remains at PC. Although the market price of consumer goods remains the same, the firm will substitute a portion of imports with local production if it chooses to enter the market.

The model assumes that there is no local production of capital goods, so the price of capital goods is also determined by imports. This assumption is supported by the fact that as a late-developing country, China manufactured very few intermediate goods or machinery at that time and had to rely on imports for them.

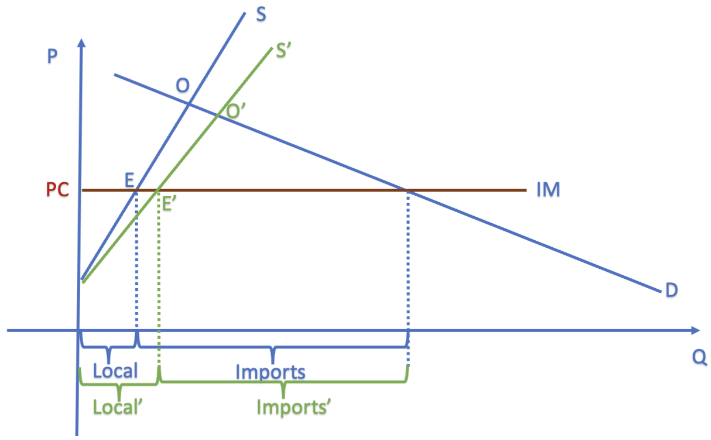


Figure 2.3: The Consumer Goods Market
This figure provides a visualization of the consumer goods market. When a new industrial firm enters, the local supply of consumer goods increases. However, it is unable to drive out all imports, so the market price is still determined by the import price.

The Setup

Given the assumptions above, the price of consumer goods and the price of capital goods in the market are modeled by

$$PC_i = H(GPC, \Gamma_i^C) \text{ and } PK_i = H(GPK, \Gamma_i^K).$$

Consumer goods prices and capital goods prices are functions of global prices and trade access. Although I consider only one market in the model, I use subscription i to distinguish the market-specific characteristics. GPC and GPK are the global prices of consumer goods and capital goods, which are not specific to the market. Γ_i^C and Γ_i^K measure the market-specific foreign trade access to consumer goods and capital goods. A higher Γ_i^C (Γ_i^K) means that the market has poorer access to consumer goods (capital goods). The parameter Γ_i^C and Γ_i^K are determined by the prices of consumer goods and capital goods at ports that the market has access to and the internal trade costs. Although Γ_i^C and Γ_i^K tend to be correlated, they are not always the same. The parameters Γ_i^C and Γ_i^K are elaborated in the next section.

The firm has a standard Cobb-Douglas production function,

$$f(L) = AL^{\alpha}\bar{K}^{1-\alpha}.$$

A is the productivity of the firm, which is known to the firm. $\bar{K}$ is the fixed amount of capital goods stock[25], which I take to be fixed to pin down the size of the firm. This

[25]In my model, I do not distinguish between materials (e.g., chemicals) and capital (e.g., machinery). They both are considered capital goods.

setting is justified by the historical fact that China lacked mature financial markets, which constrained the amount of capital that the firm could access.

The objective of the firm is to maximize profits, which is given by

$$\pi_i = f(L_i)PC_i - wL - \bar{K}PK_i.$$

Given the market prices, the optimal number of labor chosen by the firm (if it enters) is given by

$$L_i^* = \left(\frac{w_i}{\alpha A\bar{K}^{1-\alpha}PC_i}\right)^{\frac{1}{\alpha-1}}.$$

The profits is given by

$$\pi_i^* = A^{\frac{1}{1-\alpha}}\bar{K}w^{\frac{\alpha}{\alpha-1}}[\alpha^{\frac{\alpha}{1-\alpha}} - \alpha^{\frac{1}{1-\alpha}}](PC_i)^{\frac{1}{1-\alpha}} - \bar{K}PK_i.$$

Minimum Entry Condition

A necessary condition for the firm to enter the market is that that $\pi_i^* > 0$. That is,

$$\pi_i^* = A^{\frac{1}{1-\alpha}}\bar{K}w^{\frac{\alpha}{\alpha-1}}[\alpha^{\frac{\alpha}{1-\alpha}} - \alpha^{\frac{1}{1-\alpha}}](PC_i)^{\frac{1}{1-\alpha}} - \bar{K}PK_i > 0$$

Taking the log transformation,

$$\frac{1}{1-\alpha}\log(A) + \log(w^{\frac{\alpha}{\alpha-1}}[\alpha^{\frac{\alpha}{1-\alpha}} - \alpha^{\frac{1}{1-\alpha}}]) > \log(PK_i) - \frac{1}{1-\alpha}\log(PC_i)$$

Notice that $\log(w^{\frac{\alpha}{\alpha-1}}[\alpha^{\frac{\alpha}{1-\alpha}} - \alpha^{\frac{1}{1-\alpha}}])$ is a constant.

For fixed PC_i and PK_i, there exists $\underline{A}_i$ such that

$$\begin{aligned}\log(\underline{A}_i) &= (1-\alpha)\left(\log(PK_i) - \frac{1}{1-\alpha}\log(PC_i) - \log(\Sigma)\right) \\ &= (1-\alpha)\log(PK_i) - \log(PC_i) - (1-\alpha)\log(\Sigma),\end{aligned} \tag{2.1}$$

where Σ captures all the constant terms. I call this $\underline{A}_i$ *the minimum entry condition*. $\underline{A}_i$ is a function of PC_i and PK_i, so it is market-specific. Moreover, as equation (2.1) indicates, $\underline{A}_i$ increases as PK_i increases and increases as PC_i decreases. The intuition is simple: when the price of consumer goods is high, the firm has higher unit revenue and more opportunity to make profits, so the entry requirement on productivity is lower. When the price of capital goods is higher, the cost of production is higher and the firm has to be more productive to make a profit. Note that because in PC_i and PK_i are market-level variables, entry decisions are market-specific.

The Firm's Productivity and Entry Probability

During the Warlord Era, the productivity of a firm was determined not just by its knowledge of modern technology but also its managerial strategies (Zeitz, 2013). As Zeitz (2013) shows, the productivity varied greatly across firms. In the model, I assume that the prospective firm knows its productivity when making the entry decision. I further assume that the firm's productivity is a random draw from a distribution $z(A)$. I do not need to specify any functional form of $z(A)$ as long as its cumulative distribution function $Z(A)$ is regular. The probability that the firm enters the market is given by

$$Pr^{Entry}(\underline{A_i}) = 1 - Z(\underline{A_i}). \tag{2.2}$$

Given the property of cumulative distribution function, $Z(A)$ is a monotone increasing function. $Pr^{Entry}(\underline{A_i})$ therefore decreases as $\underline{A_i}$ increases. Figure 2.4 visualizes the firm's entry probability. For a certain minimum entry condition (indicated by the green vertical line), the firm will choose to enter if the productivity of the firm lies to the right of it. The shaded area is, therefore, the probability that the firm chooses to enter. If the minimum entry condition increases (the green vertical line moves to the right), the area will become smaller and the probability for the firm to enter will be lower. Equation (2.1) shows that $\underline{A_i}$ increases as PK_i increases and decreases as PC_i increases. Equation (2.1) and (2.2) together show that the entry probability of the firm $Pr^{Entry}(\underline{A_i})$ increases as PC_i increases and decreases as PK_i increases.

2.6 The Empirical Framework

2.6.1 Estimates of Firm Entry Probability, Consumer Goods Prices, and Capital goods Prices.

The model implies that firms are more likely to enter in markets where the consumer goods' price is higher and less likely to do so where the capital goods' price is higher. The model effectively summarizes the role of foreign trade, but the linkage between it and the empirical estimation requires further explanation.

To begin with, I group the data by province and treat each province as an individual market for three reasons. First, the province is the unit of my trade data (port-province level) and the trade data does not allow for empirical analysis at a more granular level. Second, different provinces faced different consumer goods prices and capital goods prices due to the distribution of treaty ports and trade costs. Grouping by province allows me to use the variations among provinces caused

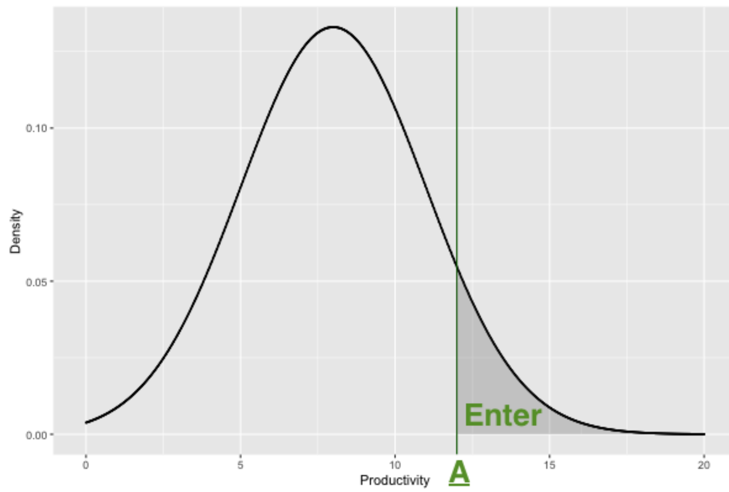


Figure 2.4: Entry Probability
This figure provides a visualization of the entry probability of a prospective investor. If the investor has productivity greater than $\underline{A}$ (to the right of the green vertical line), they will enter the market. The grey area indicates the entry probability. A higher consumer goods price or a lower capital goods price shifts $\underline{A}$ to the left, thereby increasing the investor's entry probability.

by uneven foreign trade access to explain the divergences in provincial industrial development. Third, during the Warlord Era, China disintegrated into regions controlled by various warlords, each of whom typically controlled one province. Grouping data by province aligns the analysis with the historical context

One challenge is that I cannot observe the entry probability of each prospective firm. Instead, I observe the total number of new firms each year in each province, which is correlated with the minimum entry condition $\underline{A}_i$. Suppose a province has a pool of M prospective firms. The expected number of entry is $\sum_{m=1}^{M} Pr_m^{Entry}(\underline{A_i})$. If PC_i is higher (or PK_i is lower), $\underline{A_i}$ is lower, so $Pr_m^{Entry}(\underline{A_i})$ is higher for all prospective firms. As a result, the expected number of entry is higher. Thus, the specific hypothesis to be tested is whether variance in prices across provinces is correlated with observed industrial firm entry.

A larger empirical challenge involves building estimates of the consumer goods and capital goods prices each year for each province. I classify all the commodities into consumer goods and capital goods, mainly following the classification in the CMC trade reports, and I carefully verify them manually. In general, consumer goods are products that can be consumed directly. Consumer goods mainly include textiles, food, and convenience goods like candles and matches. Capital goods are commodities used to produce consumer goods. They include both equipment (e.g., machinery and tools) and materials (e.g., steel and acids) for production. It is worth noting that China did manufacture most of capital goods itself during the Warlord Era.

I then combine both the province-port trade data and the commodity-level import data to generate an index for consumer goods prices and an index for capital goods prices each year for each province. It is important to note that although in the model PC and PK are known to the perspective firm, in reality, the prices firms used to make decisions were the *expected* arrival prices of future imports based on trade behavior. To be clear, the price measures I use are not the prices of foreign commodities that actually arrive in a province. In other words, my price measures reflect foreign trade "access," not foreign trade "consumption."

Here is why the price measures should not reflect the prices of commodities that actually arrive. Commodity-level province-port trade flows are unavailable, so I cannot calculate the prices of commodities actually consumed in a province. More importantly, even if such trade flow data were available, they would not be ideal for measuring foreign trade access, as they are entirely endogenous. Prices based on commodities actually consumed would be less informative. For example, if a province did not previously have a match factory, there would be no purchases of the capital goods needed for producing matches. However, a prospective match firm would still need to form its expected capital goods price based on prior trade activity. The price measure I introduce below can account for such cases.

The estimate of PC is given by

$$PC_{i,t} = \frac{\sum_{j=1}^{J} w_{i,j,t}\tau_{i,j,t-1}PC_{j,t}}{\sum_{j=1}^{J} w_{i,j,t}}, \text{ where } w_{i,j,t} = \log(\rho^{C}_{j,t-1}V_{i,j,t-1}). \tag{2.3}$$

In this equation, i refers to provinces, j to ports, and t to years. The superscript C means "consumer goods." This is a complex expression and I detail each part subsequently. First, P^{C}_{jt} is the price of consumer goods at Port j. As previously mentioned, hundreds of commodities were imported into China each year and I classify them into consumer goods and capital goods. For Port j,

$$PC_{j,t} = \frac{\sum_{c\in Consumer} \log(V^{T}_{c,t})P_{c,j,t}}{\sum_{c\in Consumer} \log(V^{T}_{c,t})}. \tag{2.4}$$

The subscript c refers to individual commodities. $P_{c,j,t}$ is the price of commodity c at Port j in Year t, which can be observed in my trade data. V^{T}_{c} is the total value of commodity c imported into China in Year t, which can also be observed. In a word, $P^C_{j,t}$ is the weighted average (weighted by the log of the annual value of that commodity imported into China) of the prices of all the consumer goods at Port j in Year t. For commodities that were not available at Port j, I fill in the price by the maximum price in that year. In this way, I penalize the ports with fewer commodities available. The relative price of consumer goods and capital goods varied across ports as shown in Figure 2.B3, mainly because different ports sourced foreign goods from different countries. Equation 2.4 can therefore also be viewed as a measure of port quality. The lower the value of $PC_{j,t}$, the better Port j is at providing consumer goods. During the Warlord Era, several important global events took place, such as WWI and the Russian Revolution. Although China did not participate in these events directly, they still significantly influenced the supply of foreign goods to China, which further affected the availability and prices of foreign goods at each treaty port. The price variations at treaty ports capture the shocks brought by global politics.[26]

The term $PC_{j,t}\tau_{i,j,t-1}$ is the arrival price of consumer goods from Port j to Province i. The iceberg transportation costs $\tau_{i,j,t}$ are estimated from a gravity model. The parameter $\tau_{i,j,t}$ captures several components: distance, river access, railway, and military alliance. The last variable captures the exogenous variations across regions and years introduced by the distinctive features of this historical period.[27] I rely on a classic structural gravity framework employed in many studies, such as Xu (2022) and Berger et al. (2013), to derive the trade costs. This approach deduces iceberg trade costs from actual trade value, assuming that any change in the trade cost between a province-port pair indirectly affects trade flows for all province-port pairs. The gravity model is derived from microfounded trade theory models and its coefficients are theoretically grounded. The details about the gravity model and the iceberg trade costs are in Appendix 2.B.4.

The weights are given by $w_{i,j,t} = \log(\rho^C_{j,t-1}V_{i,j,t-1})$, where $\rho^C_{j,t-1}$ represents the portion of consumer goods at Port j in the previous year and $V_{i,j,t-1}$ is the total imports volume from Port j to Province i in the previous year. I create the price index for Year t using the prices in Year t weighted by trade value in the previous year $t-1$. The log transformation discounts the extreme values. The combination

[26] For further details on how international political shocks influenced foreign trade access within China, please refer to Chapter 3 of my dissertation.

[27] For further details on how domestic warlord politics impacted foreign trade access within China, please refer to Chapter 2 of my dissertation (Feng, 2024).

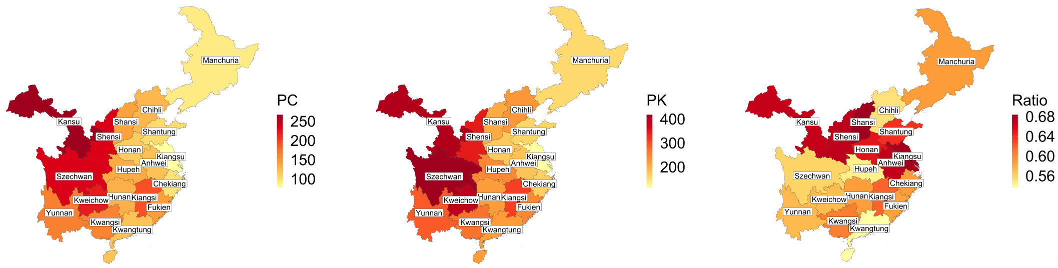
of current port-level prices with the previous year's trade flows is justified by both historical narratives and practical considerations. While investors or prospective firms could potentially obtain up-to-date price information from newspapers, their knowledge of port access and transportation costs typically relied on data from the previous year. Moreover, this approach mirrors the shift-share instrument and addresses potential reverse causality concerns.

The expected arrival prices of capital goods PK are calculated using the similar method.

The estimates of arrival prices reflect the essence of the "market access" approach. Donaldson and Hornbeck, 2016 created a measure of "market access" derived from general equilibrium trade theory to quantify the trade potential of a region. A region's market access increases when its trade cost with another region decreases, particularly when that other region has a larger population and is costly to trade with other regions. The approach in this study accounts for each region's "access to markets (ports)." The region's access to markets increases when the trade cost between the province and a port decreases, particularly when the port is of high quality (as measured by the price at the port from Equation 2.4) and the province relies heavily on the port (as measures by the weights $w_{i,j,t}$). When a region's access to markets increases, the expected arrival price will be lower. However, it should be noted that, as the model shows, improved access to markets for consumer goods, which means a lower arrival price of foreign consumer goods, actually has a negative impact on industrial firm entry.

Moreover, the expected arrival price I introduce also aligns with the price index used to measure a country's competitiveness in global trade in the trade literature (e.g., Junz and Rhomberg, 1973). The lower the expected arrival prices, the more competitive foreign goods are. However, more competitive foreign consumer goods will suppress domestic producers, while more competitive foreign capital goods will make capital goods more affordable to domestic producers, leading to opposite effects on industrial firm entry.

The price measures I introduce effectively incorporate the impact of significant global and domestic political events that introduced exogenous variations in foreign trade access. Globally, the Warlord Era coincided with key events such as World War I and the Russian Revolution of 1917. These events affected the supply of foreign goods, which, in turn, influenced the availability and prices of commodities at each port. The impact of these global events is taken into account by the prices



(a) PC 1917 (b) PK 1917 (c) Relative Prices 1917

Figure 2.5: The Spatial Patterns of Prices in 1917
Source: the CMC trade reports. See Section 2.4 for details. Price measures are explained in details in Subsection 2.6.1.

at ports calculated using Equation 2.4. Domestically, the Warlord Era was featured by national disintegration. Military factions can be viewed as "informal borders," where border is a common factor in the gravity literature. My iceberg trade costs account for this as well.[28]

Figure 2.5a and Figure 2.5b show the patterns of consumer goods prices and capital goods prices in 1917, respectively. At first glance, the patterns appear similar, which is understandable, as provinces with good access to foreign capital goods usually also had good access to foreign consumer goods. However, the patterns of the relative prices ($\frac{PC}{PK}$) differ significantly from the patterns of PC or PK, as shown in Figure 2.5c. For provinces with good access to both foreign consumer goods and foreign capital goods (e.g., Kiangsu), consumer goods might be considerably expensive *relative to* capital goods. According to the model, relative prices mattered more for industrial firm entry. Better access to capital goods relative to consumer goods (i.e., higher $\frac{PC}{PK}$) benefited domestic producers in the region.

Combining all above, the baseline estimating equation is given by,

$$\#Entry_{i,t} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \gamma_i + \gamma_t + \epsilon_{it}. \tag{2.5}$$

The coefficient β^C measures the effect of trade access to foreign consumer goods on firm entry, while β^K measures the effect of trade access to foreign capital goods. The model predicts that $\beta^C > 0$ and $\beta^K < 0$. The variable γ_i represents the province-fixed effects, which captures time-invariant, province-specific characteristics, such as natural or cultural environment. In particular, it accounts for differences in the size

[28]This paper focuses on the economic consequences of uneven foreign trade access. For a detailed explanation of the international and domestic political causes of uneven foreign trade access, please refer to the other two chapters of my dissertation.

of the pool of prospective firms across provinces. The variable γ_t represents time-fixed effects, which captures macroeconomic trends that affected all the provinces.

2.6.2 Results

2.6.2.1 Baseline

Table 2.2 reports the estimations of Equation 2.5 using three different specifications on the sample of industrial firms *outside* treaty ports. The dependent variable is the annual number of new firms in each province, and the key explanatory variables are the prices of consumer and capital goods. Asinh (inverse hyperbolic sine) transformation is similar to log transformation but it allows values to be 0. The baseline model is Ordinary Least Squares (OLS). Column (1) shows that a 1% increase in the expected arrival price of foreign consumer goods (which means a decrease in trade access to foreign consumer goods) leads to a 2.7% increase in industrial firm entry, while a 1% increase in the capital goods price results in a 1.5% decrease in entry. According to estimates, if the Chinese government had been able to double the tariffs on foreign consumer goods (from 5% to 10%, still lower than most major countries), there would have been 142 more industrial firms outside treaty ports. Similarly, if the government had removed tariffs on foreign capital goods (from 5% to 0%), 79 additional industrial firms could have emerged. Moreover, if the Chinese government had implemented a 20% tariff on all goods (as it did after regaining tariff autonomy in 1929), there would have been 252 more industrial firms. Although these numbers were not particularly large compared to China's size, they still could be considered notable progress given the country's early stage of industrialization.

Column (2) presents results from a Poisson regression, a log-linear model suitable for count data. This model suggests that a 1% increase in consumer goods prices leads to a 2.8% increase in firm entry, and a 1% increase in capital goods prices leads to a 1.8% decrease. Column (3) uses a Tobit regression, which assumes that the observed number of firm entries represents the "business potential" of a province. The business potential is left censored, because negative entry cannot be observed. This model indicates that a 1% increase in consumer goods prices leads to a 3.1% increase in industrial firm entry (the latent variable, "business potential"), while a 1% increase in capital goods prices leads to a 1.9% decrease in firm entry. The results are robust across different regression models, showing that better trade access to foreign consumer goods (lower PC) had a negative impact on industrial firm entry, while better trade access to foreign capital goods (lower PK) encouraged industrial firm entry.

These results provide important implications. First of all, these findings highlight the importance of foreign trade access in shaping regional economic development. For late-developing countries like Warlord China, improving foreign trade access in a region, for example, through modern transportation, does not necessarily promote industrialization. In fact, it is crucial to have good trade access specifically to foreign capital goods, rather than all goods. More importantly, these results confirm the market-driven mechanism. They show that even in underdeveloped areas, such as regions outside treaty ports, private participants still responded actively to market forces. Liberalized markets alone were able to induce industrialization. If the Qing government had lifted entry restrictions on private enterprises earlier, industrialization could have happened sooner, even without any other significant changes.

Table 2.C3 in the appendix reports the results on the *full* sample. The results still hold. However, using the full sample of firms may not be ideal for several reasons. First, the province-port trade data records the value of imports transited out of treaty ports into the provinces. This means that consumption by individuals and firms located within the treaty port cities was not reflected in these figures. Second, as previously mentioned treaty ports provided advanced political, legal, and financial institutions not available elsewhere. Firm entry within treaty ports might be driven by factors beyond market forces. In fact, Table 2.C4 reports the results on all firms *inside* treaty ports. The coefficients have the right sign, but they are smaller in magnitude and are not well identified statistically. Third, in the baseline results in Table 2.2, I exclude firms in the service sector. Service firms faced little competition from imports and relied less on foreign capital goods, so they might not follow the model. Despite this, Table 2.C5 shows that the results still hold even when service firms are included.

2.6.2.2 Robustness

Service Firms. Table 2.3 reports the results on service firms. The first column includes all the service firms (i.e., shipping, maintenance, insurance, banking), while the second column includes only finance firms (i.e., insurance, banking). The estimated coefficients are smaller in magnitudes and less significant. This piece of results confirms that the significant impact on industrial firms captured by Table 2.2

Table 2.2: The Impact of Foreign Trade Access on Industrial Firm Entry Outside Treaty Ports

Dependent Variables:	asinh(# Industrial)	# Industrial	asinh(# Industrial)
Model:	(1)	(2)	(3)
	OLS	Poisson	Tobit
Variables			
asinh(PC)	2.717***	2.831***	3.103***
	(0.6778)	(0.7869)	(0.9751)
asinh(PK)	-1.511***	-1.796***	-1.859**
	(0.5393)	(0.5756)	(0.7733)
Fixed-effects			
Province	Yes	Yes	Yes
Year	Yes	Yes	Yes
Fit statistics			
Observations	361	361	361
BIC	976.69	1,480.3	1055.4

Note: This table reports the results of $\#Entry_{i,t} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \gamma_i + \gamma_t + \epsilon_{it}$, using different regression models on the sample of industrial firms outside treaty ports. The dependent variable is industrial firm entry in Province i during Year t. PC measures the arrival price of foreign consumer goods, and PK measures the arrival price of foreign capital goods.
Clustered (Province-Year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

was indeed the effects of foreign trade access. For firms that faced less competition or relied less on capital goods, the prices of imports did not have a strong impact. Still, the signs of the coefficients are consistent with the baseline estimates. There are two explanations. First, some service companies, although did not compete with imports, still needed imports to provide "capital goods" (e.g., vessels and fuel). Second, when there were more industrial firms, naturally there was more demand for services (e.g., banks for loans; construction companies to build factories; and transportation firms to transport goods). However, service firms did not respond to the changes in prices nearly as much as industrial firms.

Table 2.3: The Impact of Foreign Trade Access on Service Firm Entry

Dependent Variables:	asinh(# Service)	asinh(# Finance)
Model:	(1)	(2)
	OLS	OLS
Variables		
asinh(PC)	0.5396	0.4523
	(0.4840)	(0.4257)
asinh(PK)	-0.4293	-0.6438**
	(0.3725)	(0.3227)
Fixed-effects		
Province	Yes	Yes
Year	Yes	Yes
Fit statistics		
Observations	361	361
R^2	0.52343	0.52486

Note: This table reports the OLS results of $\#Entry_{i,t} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \gamma_i + \gamma_t + \epsilon_{it}$ on the sample of service firms outside treaty ports. The dependent variable is service firm entry in Province i during Year t. PC measures the arrival price of foreign consumer goods, and PK measures the arrival price of foreign capital goods.
Clustered (Province-Year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

The Impact of Large Treaty Ports. One potential concern is that the results were driven by the spillover or agglomeration effects of large treaty ports. Therefore, I rule out this concern by subsampling. The results are reported in Table 2.4. In Column (1), I drop Kiangsu (Jiangsu) and Chekiang (Zhejiang), two richest provinces that benefited most from Shanghai (the Lower Yangzi Delta). In Column (2), I drop Chihli (Hebei), Kwangtung (Guangdong), and Kiangsu (Jiangsu), the provinces where the three largest treaty ports, Tientsin (Tianjin), Canton (Guangzhou), and Shanghai were located. In Column (3), I drop Manchuria (Northeastern of China, which later was occupied by Japanese in 1930) in case the strong impact of Japan biased the results. In Column (4), I drop all five provinces, which together account for a significant portion of firm entry. Nevertheless, the results still hold. Figure 2.C4 and Figure 2.C5 further present the leave-one-out test results, which remain consistent with the baseline findings in Table 2.2, indicating that the results are not driven by any single province.

Table 2.4: Influential Provinces/Ports Not Driving the Results

Dependent Variable:	asinh(# Industrial)			
Model:	(1)	(2)	(3)	(4)
	No CK, KS	No KS, CL, KT	No Manchuria	No all five
Variables				
asinh(PC)	2.122***	2.327***	2.743***	1.857**
	(0.6665)	(0.6988)	(0.7030)	(0.7197)
asinh(PK)	-1.950***	-1.647***	-1.491***	-1.693***
	(0.5782)	(0.6098)	(0.5523)	(0.6382)
Fixed-effects				
Province	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Fit statistics				
Observations	323	304	342	266
R^2	0.57417	0.54965	0.56817	0.41539

Note: This table reports the OLS results of $\#Entry_{i,t} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \gamma_i + \gamma_t + \epsilon_{it}$ on the sample of industrial firms outside treaty ports. The dependent variable is service firm entry in Province i during Year t. PC measures the arrival price of foreign consumer goods, and PK measures the arrival price of foreign capital goods. In each column, provinces that could potentially bias the results are excluded. CK refers to Chekiang, KS refers to Kiangsu, CL refers to Chihli, and KT refers to Kwangtung.
Clustered (Province-Year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Global Prices. Another potential concern is that the impact presented in Table 2.2 was the impact of global price changes. This concern is reasonable, given that global prices fluctuated significantly during the sample period. I aim to show that it was the variations in trade access within China (Γ^C and Γ^K in the model) that explained the differences in firm entry. To rule out the concern, I estimate the annual global prices of consumer goods and capital goods by the prices at Shanghai, and subtract those values from the baseline price measures. All the results still hold in Table 2.5, although the coefficients become slightly smaller in magnitude. Results in Table 2.5 confirm that uneven trade access within China played a major role in explaining the spatial pattern of firm entry.

Table 2.5: Subtracting Global Prices

Dependent Variables:	asinh(# Industrial)	# Industrial	asinh(# Industrial)
Model:	(1)	(2)	(3)
	OLS	Poisson	Tobit
Variables			
asinh(GammaPC)	2.203***	2.179***	2.559***
	(0.6134)	(0.6566)	(0.8677)
asinh(GammaPK)	-1.086**	-1.297***	-1.390**
	(0.4716)	(0.4692)	(0.6649)
Fixed-effects			
Province	Yes	Yes	Yes
Year	Yes	Yes	Yes
Fit statistics			
Observations	361	361	361
BIC	977.25	1,482.6	1055.6

Note: This table reports the results of $\#Entry_{i,t} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \gamma_i + \gamma_t + \epsilon_{it}$, using different regression models on the sample of industrial firms outside treaty ports. The dependent variable is industrial firm entry in Province i during Year t. $GammaPC$ measures the difference between the arrival price of foreign consumer goods and the global price of consumer goods, while $GammaPK$ measures the difference between the arrival price of foreign capital goods and the global price of capital goods.
Clustered (Province-Year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Wages. In the model, I assume that wages are exogenously fixed. The wage level is omitted from the baseline estimation. The province-fixed effects control for the time-invariant differences in wages across provinces. However, time-varying changes in wages may bias the results. Unfortunately, I cannot find reliable province-level data on wages in the industrial sector. Therefore, I have collected data on wages of farm labor from Buck (1956) each year for each province to use as proxies for industrial wages. Appendix 2.B.5 provides the details of the wage data. Table 2.6 shows that higher wages had a significantly negative impact on firm entry, but including wage does not affect the coefficients on the consumer goods price (PC) and the capital goods price (PK).[29]

[29] Wage data on Manchuria is missing, so I drop it.

Table 2.6: Regressions with Wages

Dependent Variables:	asinh(# Industrial)	# Industrial	asinh(# Industrial)
Model:	(1)	(2)	(3)
	OLS	Poisson	Tobit
Variables			
asinh(PC)	2.447***	2.924***	2.764***
	(0.6891)	(0.8464)	(1.002)
asinh(PK)	-1.341**	-1.842***	-1.682**
	(0.5282)	(0.5920)	(0.7723)
asinh(Wage)	-1.284***	-1.479***	-1.833***
	(0.3093)	(0.3534)	(0.4257)
Fixed-effects			
Province	Yes	Yes	Yes
Year	Yes	Yes	Yes
Fit statistics			
Observations	342	342	342
BIC	923.45	1,340.0	996.3

Note: This table reports the results of $\#Entry_{i,t} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \alpha Wage_{i,t} + \gamma_i + \gamma_t + \epsilon_{it}$, using different regression models on the sample of industrial firms outside treaty ports. The dependent variable is industrial firm entry in Province i during Year t. PC measures the arrival price of foreign consumer goods and PK measures the arrival price of foreign capital goods. $Wage_{i,t}$ measures the cost of labor in province i during year t. Manchuria is excluded due to missing wage data.
Clustered (Province-Year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Alternative Price Measures. Some may be concerned that the significant results I find are influenced by the specific design of the price measures. To address this concern, I employ alternative price measures, with details provided in Appendix 2.D.1. Table 2.7 shows that all the price measures yield qualitatively similar results. In particular, Column (1) shows the results using naive price measures, which rely solely on geographic distance rather than incorporating iceberg costs.

Table 2.7: Alternative Price Measures

Dependent Variable:	asinh(# Industrial)			
Model:	(1) Naive	(2) Unweighted	(3) Alternative 1	(4) Alternative 2
Variables				
asinh(APC)	1.494***	3.104***	3.190***	0.9911***
	(0.3520)	(0.7559)	(0.7384)	(0.3748)
asinh(APK)	-0.9460**	-2.281***	-2.199***	-0.7151**
	(0.3663)	(0.6529)	(0.6276)	(0.3298)
Fixed-effects				
Province	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Fit statistics				
Observations	361	361	361	361
R^2	0.61662	0.61490	0.61640	0.60371

Note: This table reports the OLS results of $\#Entry_{i,t} \sim \beta^C APC_{i,t} + \beta^K APK_{i,t} + \gamma_i + \gamma_t + \epsilon_{it}$ on the sample of industrial firms outside treaty ports. The dependent variable is industrial firm entry in Province i during Year t. APC measures the arrival price of foreign consumer goods and APK measures the arrival price of foreign capital goods, both using alternative price measures. See Appendix 2.D.1 for details on alternative price measures.
Clustered (Province-Year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

2.6.3 Instrumental Variables

One threat to my findings stems from the endogeneity concerns associated with my measures of prices. As previously noted, my measures deal with short-term reverse causality problem by using lagged trade value. Moreover, variations in my baseline price measures primarily stem from exogenous shocks brought by international and domestic politics. However, two endogeneity problems are still outstanding. First, in the model, I assume that provinces are price-takers of consumer goods prices and capital goods prices. As new firms entered in a province, prices might change accordingly. For consumer goods, the entry of new firms tended to increase local supply and reduce the demand for imported consumer goods. If this decrease in the provincial demand affected the demand-supply equilibrium at the ports trading with it, the consumer goods price in the province might decrease as more firms entered.

More firm entrants on the other hand should increase the price of capital goods, since the demand for imported capital goods increased as more firms entered. Both the coefficient of PC and the coefficient of PK then would be biased towards 0 (see Appendix 2.D.2 for detailed calculations). In this case the baseline estimates are conservative.

The second endogeneity concern is that returns to scale may bias the coefficients. Although the trade behavior of each province in our dataset looks like "centralized," in reality foreign trade was decentralized. As more firms entered, merchants in a province might gradually learn to optimize their trading strategies to secure capital goods at lower prices (similar to "bulk discount"). In this case, more firms might decrease the price of capital goods, which would bias the coefficient of PK away from 0. In summary, the coefficient of PC is biased towards 0 while the coefficient of PK is ambiguous.

I design two instrumental variables (IVs) for PC and PK respectively using military factions to address the potential endogeneity concerns. The instrument variable for the consumer goods price (PC) is given by,

$$IVPC_{i,t} = \frac{\sum_{j=1}^{J} w_{ijt} \tau_{i,j,t-1} P_{jt}^{C}}{\sum_{j=1}^{J} w_{ijt}}, w_{ijt} = \log(\rho_{j,t-1}^{C} A_{i,j,t-1} + 1), \tag{2.6}$$

I replace $V_{i,j,t-1}$(the actual trade value) with $A_{i,j,t-1}$, which A is the total imports at Port j in $t-1$ if Province i and Port j were *in the same military faction and engaged in trade* in $t-1$, while $A_{i,j,t-1}$ equals 0 otherwise. So $A_{i,j,t-1}$ measures the size of *easily accessible imports*, *not the actual trade behavior of the province*. The instrument variable for the capital goods price ($IVPK$) is defined in the same manner.

The instruments for the consumer goods price and the capital goods price must satisfy both the relevance criterion and the exclusion restriction. The relevance criterion is met, as the instruments are constructed as the weighted average of prices from treaty ports with which the province was allied and *engaged in trade*. Since the province indeed traded with these ports, the IVs are naturally correlated with the price variables. The strong correlation between the IVs and the prices is proved by the F-statistics.

The exclusion restriction requires that the IVs must be uncorrelated with the error term in the second stage of the model. This means that the IVs should influence firm entry solely through their effect on the consumer goods price and the capital goods price, and not through any other unobserved variables that might affect the dependent variable.

A three-step argument justifies the exclusion restriction. First, the IV prices are calculated as the weighted average of the prices from all allied treaty ports, with weights based on ports' total import value, not the actual trade value between the province and ports. The trade behavior of merchants in the province plays a less important role in the IVs. Second, the civil wars during the Warlord Era were limited in scale and caused minimal direct destruction (Rawski, 1989; Ch'i, 1976), so they were unlikely to destroy the firms directly. The formation, reorganization, and dissolution of military factions were likely driven by the political ideologies or personal relationships of warlords. There is no historical evidence that warlords took civilian economic interests into consideration when they made decisions on military factions. Last but not least, my instrumental variables not only measure the size of military faction that the province belonged to but specifically quantify the faction's size in terms of foreign trade. It is possible that the size of a province's military faction impacted regional resources exchanges other than province-port trade. The inclusion of total imports at allied ports and province-port trade costs nevertheless ensures that the IVs are specifically related to province-port trade, this one particular economic activity, and the IVs are unlikely to impact firm entry through other channels.

Table 2.8 reports the results of the IV regression. The coefficient on PC is larger in magnitude, while PK remains similar. The F-statistics, well above 10, confirms that the instruments are sufficiently correlated with the endogenous explanatory variables. The Wu-Hausman test indicates that the IV estimates differ significantly from the OLS estimates at the $\alpha = 0.05$ significance level. The IV results further confirm that better access to foreign consumer goods suppressed regional industrial development, whereas better access to foreign capital goods encouraged regional industrial development.

Table 2.8: The IV Regression

Dependent Variables:	asinh(# Industrial)		asinh(PK)	asinh(PC)
Model:	(1)	(2)	(3)	(4)
	OLS	IV	*First-Stage*	
Variables				
asinh(PC)	2.717***	4.650***		
	(0.6778)	(1.044)		
asinh(PK)	-1.511***	-1.735**		
	(0.5393)	(0.7618)		
asinh(IVPK)			0.5075***	-0.1457**
			(0.0775)	(0.0597)
asinh(IVPC)			-0.2810***	0.3649***
			(0.0745)	(0.0656)
Fixed-effects				
Province	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Fit statistics				
Observations	361	361	361	361
R^2	0.61133	0.58992	0.94414	0.96286
Test statistics				
F-test			48.7***	45.9***
Wu-Hausman		3.26**		

Note: This table reports the IV results of $\#Entry_{i,t} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \gamma_i + \gamma_t + \epsilon_{it}$ on the sample of industrial firms outside treaty ports. The dependent variable is industrial firm entry in Province i during Year t. $IVPC$ and $IVPK$ are the instrumental variables for the arrival prices of foreign consumer goods and foreign capital goods, using military factions as exogenous shocks to trade activity.
Clustered (Province-Year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

2.6.4 Heterogeneity

2.6.4.1 Firm Size

It is possible that large firms responded to prices differently from small firms. I use initial capital as a measure of firm size. Data on initial capital are available for 997 out of 1,069 industrial firms founded in my sample period.In this subsection, I assume that all firms with missing initial capital data are "small", which is defined below. Initial capital ranged from 10 to 9,000, but the median was 70, confirming that most firms were small in terms of capital. I divide firms into "large" and "small" by their initial capital. I classify all the industrial firms into four sectors: textile, food, convenience, and others.

For each sector, firms with the top 25% of initial capital are considered "large," while the rest are "small." Table 2.9 reports the results of Equation 2.5 for small firms and large firms separately. Column (2) shows that PC and PK had a significant impact on small firms' entry, while Column (3) show that large firms did not respond to the prices of imports. These results provide important implications. For a founder who could raise a large amount of capital, it was likely that he was capable enough to make profits regardless of the prices of imports (a high enough A in the model). Thus, their decision to enter the market (both whether to enter and where to enter) might be less influenced by market forces. Instead, they might need to give more weight to political or other connections that enabled their to raise sufficient funds.

Table 2.9: Regressions by Firm Size

Dependent Variables:	asinh(# Industrial)	asinh(# Small)	asinh(# Large)
Model:	(1)	(2)	(3)
Variables			
asinh(PC)	2.717***	2.812***	0.6108
	(0.6778)	(0.6599)	(0.4707)
asinh(PK)	-1.511***	-1.614***	0.0890
	(0.5393)	(0.5294)	(0.3874)
Fixed-effects			
Province	Yes	Yes	Yes
Year	Yes	Yes	Yes
Fit statistics			
Observations	361	361	361
R^2	0.61133	0.59544	0.44015

Note: This table reports the OLS results of $\#Entry_{i,t} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \gamma_i + \gamma_t + \epsilon_{it}$ for samples of large and small firms, defined by initial capital. The dependent variable is industrial firm entry in Province i during Year t. PC measures the arrival price of foreign consumer goods, and PK measures the arrival price of foreign capital goods.
Clustered (Province-Year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

2.6.4.2 Capital/Material Intensity

Recall that the minimum entry condition is given by,

$$\log(\underline{A}_i) = (1-\alpha)\log(PK_i) - \log(PC_i) - (1-\alpha)\log(\Sigma).$$

In the baseline estimation, I assume the elasticity of substitution between labor and capital goods, α, is fixed across all industries. However, the elasticity may vary depending on the extent to which an industry relies on capital and material. Based on the minimum entry condition, the coefficient on PC does not depend on α, but the coefficient on PK can change.

I collect industry-level data on capital intensity and material intensity from the U.S. **1920 Census: Abstract of the Census of Manufactures, 1919, Chapter 3: Individual Industries** and match it to industries in my dataset. The census data provides a detailed industry breakdown, so most industries are well matched. The US census includes data on 1) wage earners (number), 2) capital (in thousands of dollars), 3) wages (in thousands of dollars), 4) cost of materials (in thousands of dollars), 5) value of products (in thousands of dollars), and 6) value added (in thousands of dollars). I create three metrics

- Capital-to-labor ratio: $\frac{\text{capital}}{\text{wage earners}}$, in thousands of dollars per labor.
- Material-to-labor ratio: $\frac{\text{costs of materials}}{\text{wage earners}}$, in thousands of dollars per labor.
- Value added per labor: $\frac{\text{value added}}{\text{wage earners}}$, in thousands of dollars per labor.

The first two metrics are standard measures of capital and material intensity. The third metric is a popular measure of capital intensity in the literature. However, this measure reflects not only the volume of capital used but also labor productivity. Given the significant difference in human capital between China and the US during this period, the third metric may be less informative compared to the first two.

I further normalize all the intensity measures ($Intensity$) to the $0-1$ range using min-max normalization: $NI = \frac{Intensity - \min(Intensity)}{\max(Intensity) - \min(Intensity)}$.

The regression equations is given by

$$\#Entry_{i,t,s} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \kappa NI_s \times PK_{i,t} + \gamma_i + \gamma_t + \gamma_s, \tag{2.7}$$

where κ should be significantly negative since β^K is negative. That is, higher capital intensity (i.e., higher NI) will lead to greater responsiveness to the capital goods price ($\beta^K + \kappa NI$). Moreover, this regression is performed at the industry level, where s indicates an industry-specific factor.

Table 2.10: Capital/Material Intensity at the Industry Level

Dependent Variable:	asinh(# Industrial)			
Model:	(1)	(2)	(3)	(4)
	Baseline	Capital	Material	Value Added
Variables				
asinh(PC)	0.1480***	0.1480***	0.1480***	0.1480***
	(0.0345)	(0.0345)	(0.0345)	(0.0345)
asinh(PK)	-0.0688**	-0.0529*	-0.0540*	-0.0679**
	(0.0271)	(0.0278)	(0.0275)	(0.0277)
asinh(PK) × NI		-0.0885**	-0.0866***	-0.0034
		(0.0344)	(0.0229)	(0.0183)
Fixed-effects				
Year	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Fit statistics				
Observations	14,801	14,801	14,801	14,801
R^2	0.14613	0.14677	0.14747	0.14613
Within R^2	0.00143	0.00218	0.00300	0.00143

Note: This table reports the OLS results of $\#Entry_{i,t,s} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \kappa NI_s * PK_{i,t} + \gamma_i + \gamma_t + \gamma_s$. The dependent variable is industrial firm entry in Province i during Year t in Industry s. PC measures the arrival price of foreign consumer goods, and PK measures the arrival price of foreign capital goods. NI is the normalized measure of capital/material intensity
Clustered (Province-Year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

The results are presented in Table 2.10. The sign of κ is consistent with the prediction, indicating that capital- or material-intensive industries were more responsive to the capital goods price. However, the estimate is not significant in Column (4), which may be attributed to the reason explained above.

2.7 Conclusion

During the first thirty years of the twentieth century, much of which is known as the Warlord Era in China's history, China's economy began to industrialize despite the lack of a conducive political environment. The institutional changes between 1904 and 1907, particularly the 1904 Company Law, relaxed entry restrictions on private businesses. Following that, the private sector replaced the public sector as the driving force in China's industrialization. Thousands of private industrial firms, primarily in the consumer goods industry, emerged in a competitive, open, and fragmented economy.

This paper develops a market-driven mechanism of industrialization to explain industrial firm entry. Local producers make entry decisions based on prices in the local market. Foreign trade access plays a crucial role in shaping these prices given that the market is highly competitive. The model shows the opposite effects of foreign consumer goods and foreign capital goods. On one hand, lower prices of imported consumer goods in the market suppress revenue of domestic producers, discouraging them from entering the market. On the other hand, lower prices of capital goods reduce the costs of production, encouraging local producers to enter the market. The key driver of industrial firm entry is the foreign trade access to consumer goods *relative to* capital goods.

Combining granular trade data, I estimate an expected arrival price of foreign consumer goods and an expected arrival price of foreign capital goods each year for each province. I then link the prices to industrial firm entry. The empirical analysis supports the model's predictions. A 1% increase in the expected arrival price of imported capital goods decreased industrial firm entry by 1.5%, while a 1% increase in the expected arrival price of imported consumer goods increased industrial firm entry by 2.7%. The results highlight the role of foreign trade access in shaping regional economic development. Unlike in early-industrializing countries, better foreign trade access did not necessarily promote industrial growth in late-developing countries, as overall improvements in trade access lowered the expected arrival prices of both foreign consumer goods and foreign capital goods. Furthermore, these findings demonstrate that liberalized markets alone were able to induce some industrialization. Private participants, even in less developed areas (i.e., areas outside treaty ports), responded to market forces. If the Qing government had lifted entry restrictions on private industrial initiatives earlier, industrialization could have occurred sooner.

The existing literature, in particular (Rawski, 1989), recognizes that during the Warlord Era, the private sector dominated the economy. It has also noted that foreign trade was the root of economic growth, and China's industrialization was a regional phenomenon. My work is the first to connect these different facts, weaving them into a comprehensive and cohesive narrative. Additionally, unlike most existing works (e.g., Jia, 2014; Ma, 2008), this paper focuses on regions other than treaty port cities. The treaty port cities made less than 1% of China's territory and population. Sustained growth required firm entry beyond the ports, but the rest of China has received little attention in the literature.

In the long run, China's market-driven industrialization before 1930 proved insufficient in resisting a rapidly industrializing Japan. Would the outcome have been different if there had been an effective central government? Perhaps more investment would have been directed toward heavy industry. Trade barriers created by military factions would have been eliminated. The government could also have built more public infrastructure, such as railways. However, China still had to remain an open economy. Reductions in trade barriers would have decreased the arrival prices of both foreign consumer goods and foreign capital goods, which, according to the findings in this paper, might not necessarily have promoted industrialization.

The Warlord Era witnessed a liberalized, open, and decentralized economy, a rarity in China's history. China's experience during this period and the findings in this paper shed new light on the economic opportunities and challenges faced by late-developing countries.

2.A Warlordism

During the Warlords Era, provinces were controlled by different warlords. Table 1.2 lists major military factions. The Kuomintang was certainly the best known among these factions. It reunified China under Chiang Kai-shek in 1928 and ruled mainland China from 1927 to 1949. However, during the most time of the Warlord Era, the KMT was influential only in southern China. The actual controlled areas of a faction changed over time. The bases listed in Table 1.2 were provinces that each faction held for relatively long time, but they were not the only provinces a faction held nor the provinces a faction always held.

Military factions were not binding. Warlords occasionally changed their factions of their own will. An notable example is a controversial general — Feng Yu-hsiang. Feng was first a follower of Yuan Shih-kai, but he stood on the opposite side of Yuan during the National Protection War. He joined the Chihli Faction in against Fengtien Faction during the First Chihli-Fengtien War, but he chose to betray the Chihli Faction during the Second Chihli-Fengtien War. He later again betrayed the Fengtien Faction and joined the KMT during the Northern Expedition. And he eventually left the KMT and joined the CPC.

Major wars affected the territories controlled by each faction. On the eve of the Anhwei-Chihli War, the Anhwei Faction controlled Shantung, Anhwei, Chekiang, and Fukien. Defeated by the Chihli Faction, the Anhwei Faction lost control over Shantung and Anhwei. The Chihli Faction became the largest faction after it defeated the Fengtien Faction during the First Chihli-Fengtien War. However, it lost control over all the provinces in Northern China after the second Chihli-Fengtien War. Moreover, the Chihli Faction split after the war, with Wu P'ei-fu and Sun Ch'uan-fang each controlling a few provinces.

Since warlords acted as the *de facto* civil governors, military factions affected inter-regional trade. An example is the trade of Opium. Opium from Yunnan and Kweichow was shipped over a well-established trade route to Western Hunan, where it could be sent northward to the Yangtze Valley or southward to the Canton delta. The allegiance of the warlord controlling western Hunan determined which route would be selected.[30] Although the trade of opium was not something to be encouraged, this example illustrates the connection between military alliance and inter-regional trade. This type of connection has also been recognized in numerous

[30]The Cambridge History of China, vol. 12. Republican China 1912–1949, part 1, p296

textual records. For example, a treaty port report[31] notes that

> The tea trade has not prospered during the decade owing to the great difficulties and risks attending all interprovincial commercial transactions since the inauguration of the Republic, and more especially during the years of warfare between Yunnan and Szechwan.

[31] *Decennial Reports on the Trade Navigation Industries, etc., of the Ports Open to Foreign Commerce in China and Corea, and on the Conditions and Development of the Treaty Port Provinces*, 1912-1921, p 372

2.B Additional Data

2.B.1 Supporting Data for the Introduction Section

Country	1913	1925
China	4-5	4-5
UK	0	5
Japan	25-30	
France	20	21
Germany	13	20
Australia	16	27
Canada	26	23
USA	44	37
Argentina	28	29
Brazil	50-70	
Mexico	40-50	

Table 2.B1: Tariff Rates
Source: Findlay and O'rourke (2009). Power and plenty: trade, war, and the world economy in the second millennium. In *Power and Plenty*. Princeton University Press. Page 403 and Page 444.

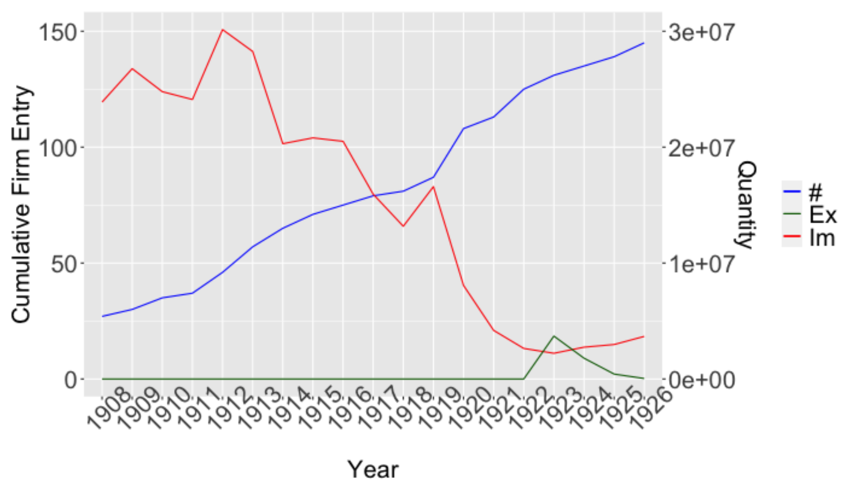
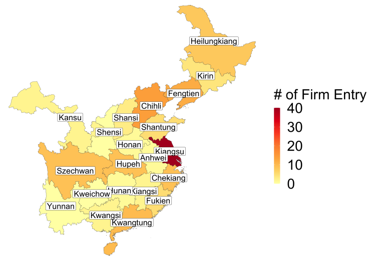
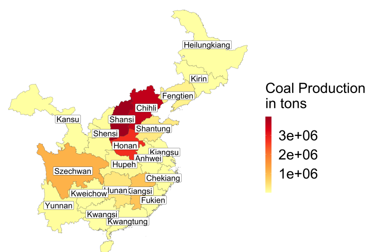


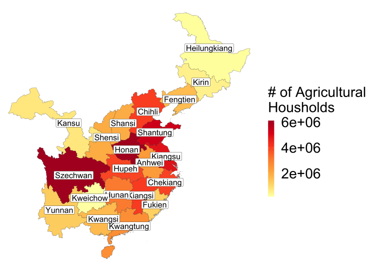
Figure 2.B1: The Matchstick Industry
Source: Import and export data are from the CMC trade reports. Firm entry data are from Du (1991). See Section 2.4 for details.



(a) Firm Entry in 1914



(b) Coal Production in 1914



(c) Agricultural Households in 1914

Figure 2.B2: Firm Entry v.s. Labor Supply & Coal Production

Firm entry data are from Du (1991). Please see Section 2.4 for details. Coal production data and agricultural household data are from *Nongshang tongji biao* (Reports of Statistics on Agriculture and Commerce), published by the Nongshang Bu Zongwu Ting Tongji Ke (Bureau of Agriculture and Commerce). Numbers of coal production are adjusted to ensure the calculated prices fall within the acceptable range.

2.B.2 Founders

This subsection provides information on founders in Honan (Henan) and Shantung (Shandong), which serves as qualitative evidence on capital mobility. The goal of this section is to show that not all companies in a province were founded by people born in that province. It was possible for people from other places to raise funds through personal connections and invest in profitable markets.

Honan

Honan (Henan) was and remains as one of the most populated province in China. However, the economic development in Honan was mediocre. There was no treaty port in Honan. There were in total 40 firms established in Honan between 1908 and 1926. Here are information on founders in Honan.

- Xiangyue Mu, born in Shanghai, is one of the most famous capitalists in prewar China. He earned a maste's degree in the US and established modern textile factories in many provinces in China. In my dataset, Mu ran five textile factories, and four of them were in Shanghai. The one in Honan was established in 1919 and had high initial capital.
- Xie Hengchuang, born in Zhenhai, Chekiang (Zhejiang). He invested in several coal mines and shipping companies in China. He established an egg factory in Honan in 1919.
- Jin Shaoqing, born in Tientsin. He was the son of the director of a British bank in Tientsin. He established a flour factory in Honan in 1914.
- Lu Guanli, born in Zhongshan, Kwangtung (Guangdong). He was the director of an American bank. He established an electric bulb factory in Honan in 1923.
- Yuan Shikai was born in Honan. There were several factories established by Yuan's relatives.

Shantung

Shantung was relatively active in manufacturing. There were in total 115 firms founded between 1900 and 1926. Shantung had three treaty ports: Kiaochow, Chefoo, and Lungkow. These ports were connected closely to Germany before WWI and Japan after WWI.

- Rong Zongjing, born in Wuxi, Kiangsu. He started the flour first factory in his hometown and then established 18 factories in different places. The one in Shantung was established in 1921.

- Ding Daojin, born in Pingyuan, Kweichow. He established a paper factory in 1909. He was an official in Shantung during the Qing.

- Gu Siyuan, born in Taicang, Kiangsu. He established one of the largest modern glass factories in Shantung in 1905. He was a relative of Qing's Central Bank's director Zhang Yunyan.

- One of the most famous warlords, Quan Qirui, born in Hefei, Anhwei, established a large sugar factory in 1921.

2.B.3 Price Ratios At Ports

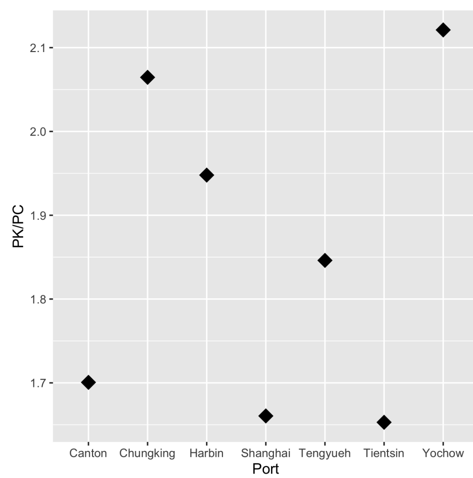


Figure 2.B3: Price Ratios at Ports in 1917
Source: the CMC trade reports. See Section 2.4 for details. This figure shows the price ratios of capital goods to consumer goods ($\frac{PK}{PC}$) at selected treaty ports.

2.B.4 The Iceberg Trade Costs

I estimate the iceberg trade costs(τ_{ijt}) using a gravity model. The gravity model assume that two larger economies with a smaller trade cost will trade more intensively. I adopted the setting from Anderson and Van Wincoop (2003). This form of gravity model can recover an explicit trade cost function. This setting is used by many studies, e.g., Berger et al. (2013) and Xu (2022).

$$V_{ijt} = \frac{Y_{it} \cdot Y_{jt}}{Y_t^T} \left[\frac{\tau_{ijt}}{P_{it} P_{jt}} \right]^{1-\sigma} \tag{1}$$

V_{ijt} denotes the trade flow between Province i and Port j during Year t. Y_{it}, Y_{jt}, and Y_t^T are the size terms for Province i, Port j, and the entire economy in Year t, respectively. The parameter σ is the elasticity of substitution between goods. τ_{ijt} measure the bilateral trade cost between Province i and Port j in Year t. P_{it} and P_{jr} are multilateral resistance terms for Province i and Port j, which are complex non-linear functions of the full set of bilateral cost barriers τ_{ijt}. In this model, a change in the bilateral trade cost between any province and port will impact all the trade routes.

Taking natural logs and rearranging gives:

$$\log(V_{ijt}) = \log(Y_{it}) + \log(Y_{jt}) - \log(Y_t^T) + (1-\sigma)\tau_{ijt} - (1-\sigma)[\log(P_{it}) + \log(P_{jt})] \tag{2}$$

I assume that the trade cost function contains four variables: $Diff\_Faction_{ijt}$, $Distance_{ij}$, $Railway_{ij}$, and $River_{ij}$. $Distance_{ij}$ measures the geographic distance between Province i and Port j. This is a variable common in the literature. $Railway_{ij}$ measure whether Province i and Port j's province were connected by a railway line. Notice that this variable is not time-varying because during the sample period, there was hardly any new inter-provincial railway. $River_{ij}$ indicates whether Province i and Port j are both along the Yangtze River. Yangtze River is the major, if not the only, riverway connecting the west and the east of China. This variable aims to measure the accessibility of river transportation for trade between Province i and Port j. Given the underdevelopment of modern transportation in China during that period, being able to use waterway could possibly reduce trade costs. $Diff\_Faction_{ijt}$ measures whether Province i and Port j's province were in different factions in Year t. This is a time-varying variable that captures the impact of political instability on province-port trade.

The trade cost function is given by:

$$\tau \equiv e^{\mu_1 \ln(Distance_{ij}) + \mu_2 I_{ij}^{Railway} + \mu_3 I_{ij}^{River} + \mu_4 I_{ijt}^{Diff\_Faction}}. \tag{3}$$

Therefore, the estimating equation is given by

$$\log(V_{ijt}) = \alpha_1 \log(Distance_{ij}) + +\alpha_2 I_{ij}^{Railway} + \alpha_3 I_{ij}^{River} + \alpha_4 I_{ij}^{Diff\_Faction} + \gamma_{it} + \gamma_{jt} + \epsilon_{ijt} \tag{4}$$

$\log(Y_{it})$, $\log(Y_{jt})$, $\log(Y_t^T)$, and $(1-\sigma)[\log(P_{it}) + \log(p_{jt})]$ are all absorbed by Province-Year fixed effects (γ_{it}) and Port-Year fixed effects (γ_{it}). $\alpha \sim (1-\sigma)\mu$. That is to say, I cannot estimate σ and parameters in the trade cost function separately. The sample ranged from 1907 to 1928.

Table 2.B2 represents the results of the regression.

As previously mentioned, I cannot separate these two components without knowing the value of σ. I then set the value of σ to 8, which is commonly used in the literature when varieties are to some extent similar. I choose this number because I assume that although available commodities were different across ports, but ports still shared many goods, so the trade flows are "similar." Different choices of σ lead to qualitative similar results in the baseline regressions.

This gives the trade cost function

$$\tau_{ijt} = e^{0.33 \log(Distance_{ij}+1) + 0.17 I_{ijt}^{Diff\_Faction} - 0.20 I_{ij}^{River} - 0.52 I_{ij}^{Railway}}.$$

As expected, distance and belonging to different military factions increased the bilateral trade costs, while riverway connections and railway connections decreased the trade costs.

Table 2.B2: The Gravity Model

Dependent Variable:	log(Value + 1)
Model:	(1)
Variables	
log(Distance+1)	-2.342***
	(0.1206)
River	1.375***
	(0.3983)
Railway	3.629***
	(0.3011)
Diff_Faction	-1.223***
	(0.2544)
Fixed-effects	
Port_Year	Yes
Province_Year	Yes
Fit statistics	
Observations	4,606
R^2	0.55455

Note: This table reports the results of the gravity model $\log(V_{ijt}) = \alpha_1 \log(Distance_{ij}) + +\alpha_2 I_{ij}^{Railway} + \alpha_3 I_{ij}^{River} + \alpha_4 I_{ij}^{Diff\_Faction} + \gamma_{it} + \gamma_{jt} + \epsilon_{ijt}$. The dependent variable is the trade value between Province i and Port j during Year t. $Distance_{ij}$ measures the geographic distance between the province and the port. $River$ indicates whether the province and the port were both along the Yangtze River. $Railway$ measures whether the province and the port were connected by railway. $Diff\_Faction$ indicates whether the province and the port were belonged to different military factions.

Clustered (Port_Year) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

2.B.5 Farm Labor Wages

The data on farm labor wages is collected from **Index Numbers of Wages of Farm Year Labor** in *Land utilization in China* (Buck, 1956). It is survey data, ranging from 1901-1933. For each province, it surveyed a few counties. For some counties, some years are missing. The reference year is 1926. For all the counties, their index for 1926 is 100. These indices therefore were not comparable among provinces. However, they can reflect the trend in each province. This works for the regression since the time-invariant differences among provinces are controlled by province fixed effects and now adding wage data controls for changes in a province across years. It does not include Manchuria, so the number of observations decreases by 19 (the sample period is 19 years). I interpolate missing numbers for counties and then take the average of all the counties in each province.

2.C Additional Regression Results

Table 2.C3: The Impact of Foreign Trade Access on the Full Sample

Dependent Variables:	asinh(N)	N	asinh(N)
Model:	(1)	(2)	(3)
	OLS	Poisson	Tobit
Variables			
asinh(PC)	2.405***	2.057***	2.762***
	(0.6331)	(0.5958)	(0.7722)
asinh(PK)	-1.624***	-1.140**	-1.988**
	(0.5184)	(0.4430)	(0.6318)
Fixed-effects			
Province	Yes	Yes	Yes
Year	Yes	Yes	Yes
Fit statistics			
Observations	361	361	361
BIC	915.24	1,820.8	1015.6

Note: This table reports the results of $\#Entry_{i,t} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \gamma_i + \gamma_t + \epsilon_{it}$, on the full sample of firms using various regression models. The dependent variable is firm entry in Province i during Year t. PC measures the arrival price of foreign consumer goods, and PK measures the arrival price of foreign capital goods.
Clustered (Province-Year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 2.C4: The Impact of Foreign Trade Access on Firm Entry Inside Treaty Ports

Dependent Variables:	asinh(# N)	# N	asinh(# N)
Model:	(1)	(2)	(3)
	OLS	Poisson	Tobit
Variables			
asinh(PC)	1.239	1.282	1.766*
	(0.7862)	(0.8227)	(0.9811)
asinh(PK)	-0.7162	-0.2713	-1.241
	(0.6171)	(0.6098)	(0.7578)
Fixed-effects			
Province	Yes	Yes	Yes
Year	Yes	Yes	Yes
Fit statistics			
Observations	266	266	266
BIC	654.22	1,026.9	725.5

Note: This table reports the results of $\#Entry_{i,t} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \gamma_i + \gamma_t + \epsilon_{it}$, on the sample of firms insides treaty ports using various regression models. The dependent variable is firm entry inside treaty ports in Province i during Year t. PC measures the arrival price of foreign consumer goods, and PK measures the arrival price of foreign capital goods. Because some provinces did not have any treaty port, the number of observations is smaller in this table.
Clustered (Province-Year) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 2.C5: The Impact of Foreign Trade Access on All Firm Entry Outside Treaty Ports

Dependent Variables:	asinh(N)	N	asinh(N)
Model:	(1)	(2)	(3)
	OLS	Poisson	Tobit
Variables			
asinh(PC)	2.688***	2.463***	3.183***
	(0.6746)	(0.7178)	(0.9055)
asinh(PK)	-1.599***	-1.668***	-2.010***
	(0.5418)	(0.5109)	(0.7232)
Fixed-effects			
Province	Yes	Yes	Yes
Year	Yes	Yes	Yes
Fit statistics			
Observations	361	361	361
BIC	970.34	1,575.8	1062.0

Note: This table reports the results of $\#Entry_{i,t} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \gamma_i + \gamma_t + \epsilon_{it}$, on the sample of all firms outside treaty ports using various regression models. The dependent variable is firm entry in Province i during Year t. PC measures the arrival price of foreign consumer goods, and PK measures the arrival price of foreign capital goods.

Clustered (Province-Year) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

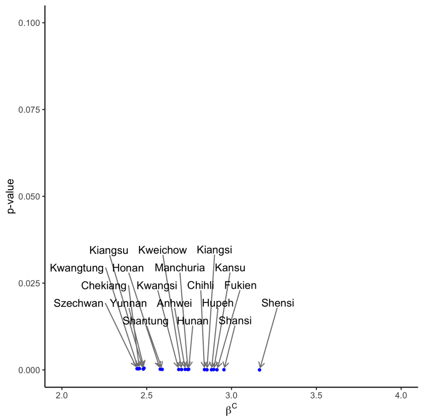


Figure 2.C4: Leave-One-Out PC

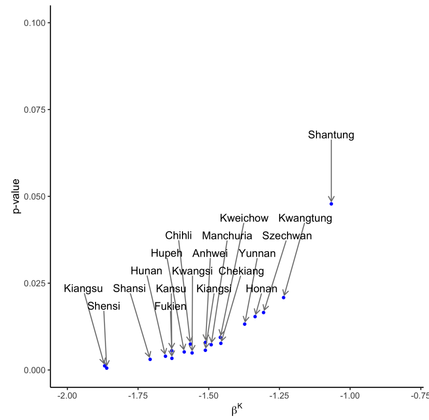


Figure 2.C5: Leave-One-Out PK

Figure 2.C4 and Figure 2.C5 present the leave-one-out test results for the OLS estimates of $\#Entry_{i,t} \sim \beta^C PC_{i,t} + \beta^K PK_{i,t} + \gamma_i + \gamma_t + \epsilon_{it}$. The label indicates the province that is excluded. The results remain consistent with the baseline findings in Table 2.2, indicating that the baseline results are not driven by any single province.

2.D Additional Calculations

2.D.1 Alternative Price Measures

To ensure that my results are not driven by the specific method used to create the price measures, I explore alternative price measures, all of which produce consistent results.

In all the following equations, i refers to provinces, j to ports, c to commodities, and t to years.

- Naive Price Measure: It uses the simplest way to calculate the expected arrival price. Instead of using the iceberg trade cost, it uses only the geographic distance. For the weights, rather than use a function of trade value in the previous year, this price measure uses simple the trade value in the same year.

$$PC_{i,t} = \frac{\sum_{j=1}^{J} w_{i,j,t} \log(Dist_{i,j}) PC_{j,t}}{\sum_{j=1}^{J} w_{i,j,t}}, \text{ where } w_{i,j,t} = V_{i,j,t}, \tag{5}$$

  where

$$PC_{j,t} = Mean_{c \in Consumer}(P_{c,j,t}). \tag{6}$$

  For the price at the port, rather than using a weighted average, this price measure uses a simple average. Moreover, it does not fill the missing prices and simply drops them.

- Unweighted Price Measure: Instead of using weighted averages, this price measures uses only simple averages.

$$PC_{i,t} = Mean_{j, s.t., V_{i,j,t-1} > 0}(\tau_{i,j,t-1} PC_{j,t}), \tag{7}$$

  where

$$PC_{j,t} = Mean_{c \in Consumer}(P_{c,j,t}) \tag{8}$$

- Alternative 1: In the baseline price measures, I first aggregate the prices at each port and then further aggregate them for each province. Alternatively, I calculate the arrival price of each commodity from each port to each province and then aggregate only at each province.

$$PC_{i,c,t} = \frac{\sum_{j=1}^{J} w_{i,j,t} (\tau_{i,j,t-1} PC_{c,j,t})}{\sum_{j=1}^{J} w_{i,j,t}}, \text{ where } w_{i,j,t} = \log(V_{i,j,t-1} + 1). \tag{9}$$

  Then

$$PC_{i,t} = \frac{\sum_{c \in Consumer} \log(V_{c,t}^{T}) PC_{c,i,t}}{\sum_{c \in Consumer} \log(V_{c,t}^{T})}. \tag{10}$$

  If $PC_{c,j,t}$ is missing, I fill it with the maximum price, $\max_{j \in J}(PC_{c,j,t})$.

- Alternative 2: This price measure is a variation of Alternative 1. If $PC_{c,j,t}$ is missing, I fill in $(\tau_{i,j,t-1}PC_{c,j,t})$ in the calculation of $PC_{i,c,t}$ using the province-specific maximum, $\max_{j,s.t.,V_{i,j,t-1}>0}(\tau_{i,j,t-1}PC_{c,j,t})$. If $\max_{j,s.t.,V_{i,j,t-1}>0}(\tau_{i,j,t-1}PC_{c,j,t})$ is also missing, I then fill it with the maximum among all province-port pairs, $\max_{i,j,s.t.,V_{i,j,t-1}>0}(\tau_{i,j,t-1}PC_{c,j,t})$.

2.D.2 Endogeneity

I consider the potential endogeneity problem between firm entry($\#Entry$) and consumer goods price (PC). For ease of writing, I denote $\#Entry$ as y and PC as x. First, higher PC will encourage firm entry.

$$y = \alpha x + \epsilon_1, \text{ where } \alpha > 0. \tag{11}$$

Second, more firm entry decreases PC.

$$x = \beta y + \epsilon_2, \text{ where } \beta < 0. \tag{12}$$

Moreover, assume the error terms ϵ_1 and ϵ_2 are independent, so $E(\epsilon_1\epsilon_2) = E(\epsilon_1)E(\epsilon_2) = 0$. Combining Equation 11 and Equation 12,

$$x = \frac{\beta\epsilon_1 + \epsilon_2}{1-\alpha\beta} \text{ and } y = \frac{\alpha\epsilon_2 + \epsilon_1}{1-\alpha\beta} \tag{13}$$

The projection of y on x is therefore

$$\alpha^* = \frac{E[xy]}{E[x^2]} = \frac{E[(\beta\epsilon_1 + \epsilon_2)(\alpha\epsilon_2 + \epsilon_1)]}{E[(\beta\epsilon_1 + \epsilon_2)^2]} = \frac{\beta E[\epsilon_1^2] + \alpha E[\epsilon_2^2]}{\beta^2 E[\epsilon_1^2] + E[\epsilon_2^2]}. \tag{14}$$

Notice that all the terms contain $E[\epsilon_1\epsilon_2]$ equal 0. The estimated coefficient from the OLS regression converges to α^*. However, α^* does not equal to α.

$$\alpha^* - \alpha = \frac{\beta E[\epsilon_1^2] + \alpha E[\epsilon_2^2] - \alpha\beta^2 E[\epsilon_1^2] - \alpha E[\epsilon_2^2]}{\beta^2 E[\epsilon_1^2] + E[\epsilon_2^2]} = \frac{\beta(1-\alpha\beta)E[\epsilon_1^2]}{\beta^2 E[\epsilon_1^2] + E[\epsilon_2^2]} < 0 \tag{15}$$

So the OLS will underestimate the true effect of consumer goods price on firm entry.

A similar calculation applies to PK.

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Chapter 3

A GEOGRAPHIC ACCIDENT?

3.1 Introduction

Coal played a central role in the Industrial Revolution. Pomeranz (2000) argues that one reason why Europe, rather than China, was the first to industrialize was its favorable geographic distribution of coal. Europe's development was largely the result of a "geographic accident" rather than fundamental differences in technical skill or market efficiency. While a substantial body of research has examined coal markets in European countries (e.g., Allen, 2023; Burhop and Lübbers, 2009; Henriques and Sharp, 2021), studies of China's coal markets remain limited.

Due to the Qing government's strict restrictions on coal mining, only a few coal mines existed before 1900, concentrated in northern China. These mines were located far from the commercial centers in central and southern China. This geographic mismatch led to high energy costs that posed significant challenges to industrialization (Pomeranz, 2000). However, while natural resources are ecologically endowed, their exploitation is a social outcome. By examining coal markets in the early Republican Era (1912–1919), the period immediately following the collapse of the Qing, this paper sheds light on how China's coal markets developed in a more liberalized environment. The findings offer insights into what coal markets during the Qing might have looked like under alternative institutional conditions. Fundamentally, were the fuel constraints faced by commercial centers in Qing China purely the result of geographic disadvantage, or were they also the result of unfavorable institutions?

Following the collapse of the Qing dynasty, the early Republican period witnessed a wave of market liberalization. The private sector replaced the public sector as the leading force behind industrial growth (Rawski, 1989). In the coal industry, this was reflected in the entry of numerous small private coal mines. While large coal mines remained concentrated in northern China, far from major commercial centers (e.g., the Lower Yangzi), as noted by Pomeranz (2000), these small private mines were scattered across the country. Private sector participation in coal mining decentralized production and gave rise to competitive local markets.

A prevailing view about the Chinese coal industry is that China had difficulty producing high-quality coal suitable for industrial use. However, raw coal—primarily used for domestic heating—already played an important role in facilitating industrialization. Even in Britain, during the early stages of industrial development, coal was not used for industry but for household needs. Nevertheless, the availability of inexpensive coal helped reduce the cost of other energy sources that could be used for industry. In addition, the use of coal reduced reliance on land-intensive energy sources, such as charcoal, thereby easing the constraint that finite land supply imposed on economic growth (Pomeranz, 2000).

This paper leverages a newly digitized dataset of county-level coal prices and outputs, compiled from archival records of an annual survey conducted by the Republican government: *Nongshang Tongji Biao* (Survey of Agriculture and Commerce). The survey recorded county- or provincial-level data for over one hundred commodities produced in the surveyed locations. For the purposes of this study, a key advantage of this dataset is that it contains not only price data but also local output data. The output data confirms the existence of small coal mines, as coal was produced in many counties across all provinces, not only in regions where large coal mines were present.

This paper first estimates the interregional integration of the coal market in China from 1912 to 1919. Market integration is estimated using price correlations among local markets. The intuition behind this measure is that if local markets were well integrated, prices should converge across regions, and any local shock would be transmitted across all markets. I use three methods to estimate interregional integration: correlation length, national versus local shocks, and cointegration analysis. These approaches are employed by Roehner and Shiue (2000), Keller and Shiue (2007), and Shiue and Keller (2007), respectively. The first two methods are particularly well suited to my dataset, which consists of a short panel (eight years) with a large number of observations each year. The third method, pairwise cointegration analysis among price series, takes advantage of the relatively large number of uninterrupted price series available in the dataset. Moreover, although Roehner and Shiue (2000), Keller and Shiue (2007), and Shiue and Keller (2007) uses grain prices, the estimation of market integration is independent of the absolute magnitude of prices. As such, the estimates reported in these studies provide a useful benchmark for comparison with the results presented in this paper.

These methods reveal that, overall, market integration remained limited to smaller scales (within provinces), with virtually no integration observed beyond 75 km during 1912–1919. These findings are in line with the historical context. First, China's modern transportation infrastructure, particularly railways and paved roads, did not undergo rapid development until the 1930s. Second, although coal was an important source of energy, it had a low value-to-weight ratio and could often be replaced with other fuels, such as wood, in many regions. At a broad level, these findings support Pomeranz (2000)'s argument that commercial centers in Qing China faced difficulties in acquiring cheap coal.

However, a closer look reveals additional insights. First, I compare the periods 1912–1915 and 1916–1919. These two periods differ in terms of political environment: during the first half, China remained politically integrated, whereas the second period marked the beginning of warlordism, when the country was divided into regions controlled by warlords. I find that between 1912 and 1915, the coal market rapidly integrated spatially, showing signs of integration beyond the provincial level. However, market integration vanished after 1916. These findings are consistent with Feng (2025), which shows that political disintegration introduces additional internal trade costs.

Unlike grain markets, supply shocks in coal markets were not necessarily random. Grain production was constrained by the finite supply of farmland. As a country with a long agrarian history, nearly all the arable land in China had already been developed. Therefore, supply shocks in grain output were more likely driven by random weather conditions rather than human factors. In contrast, coal deposits remained largely unexploited before the Republican period, leaving room for the development of new coal mines. The development of new coal mines was shaped by human decisions and coal production was also less susceptible to natural factors such as weather. The relaxation of restrictions on private participation made it possible for small coal mines to enter the market. Therefore, it is meaningful to study how market signals influenced the supply shocks observed in the coal markets.

Leveraging the output data, I find that private coal mines did, in fact, respond to market incentives. Counties that experienced high coal prices in the previous year were more likely to exhibit "positive supply shocks," which implied the entry of small coal mines. Higher prices increased the expected profits for prospective investors, which encouraged their entry. In addition to high absolute prices, counties with prices higher than those of neighboring areas were also more likely to experience entry next year. Higher relative prices indicated less competition after entry, which also encouraged local producers. From this perspective, limited spatial integration may not have been purely a disadvantage; rather, it may have created incentives for local mining development. Meanwhile, the improvements in market integration observed during the first half of the period may have been driven not only by increased trade activity but also by the strategic entry of small producers that also contributed to price convergence among regions.

Although the location of coal deposits did leave Qing commercial centers facing high energy costs, this paper highlights the potential for the entry of small coal mines and the improvements in market integration under a more liberalized economy. Had the Qing government relaxed restrictions on private participation in the coal industry, the improvements in market integration observed during 1912–1915 might have occurred earlier and lasted longer. While it would be too arbitrary to conclude that the entry of small coal mines could have enabled Qing China to achieve an energy transition on par with Britain in the 19th century, their development could nonetheless have alleviated some of the pressures associated with land-intensive energy supply in many parts of China.

This paper contributes to our understanding of the grand energy transition from biomass to fossil fuels. The Great Divergence literature emphasizes that the successful transition to coal was a cornerstone of Britain's industrial strength in the nineteenth century (Pomeranz, 2000; Allen, 2009; Wrigley, 2013). While some descriptive evidence exists regarding China's difficulties in transitioning to coal, this paper provides the first quantitative analysis of China's coal markets and formally documents the fuel constraints the country faced during its industrialization.

More importantly, this paper emphasizes the role of institutions in driving energy transitions. Although the distribution of natural resources is largely determined by ecological randomness, the decision of whether and when to extract those resources is fundamentally shaped by institutions. David and Wright (1997) argues that the "natural resource abundance" observed in the United States between 1870 and 1910 was an endogenous and "socially constructed" outcome. Legal, institutional, technological, and organizational adaptations created strong incentives for the exploration of natural resources, ultimately leading to the explosive growth of the U.S. mineral economy. Similarly, this paper argues that although the uneven distribution of coal was a geographic fact, the development of coal markets was shaped by institutions. As Allen (2012) notes, historical energy transitions offer valuable insights for the ongoing shift from fossil fuels to green energy. Neither natural endowments nor scientific advances alone are sufficient to drive such transitions (Keay, 2007; Allen, 2012). This paper underscores the importance of private sector participation in facilitating energy transitions, highlighting one institutional condition that may be critical to their success.

Broadly, this paper contributes to the literature on the relationship between natural resources and economic growth. A central debate in this literature concerns whether the so-called "resource curse" arises from the resources themselves or, in fact, from the quality of institutions. Clay and Weckenman (2014) shows that the relationship between natural resources and economic growth diverged between the U.S. South and non-South after 1970, following improvements in political institutions in the South. At the macro level, Mehlum, Moene, and Torvik (2006) demonstrate that weaker institutions amplify the negative effects of resource abundance. Although this paper does not directly examine the impact of resources on growth, it nonetheless highlights the critical role of institutions in shaping how resources are exploited.

This paper further contributes to the literature on market integration in China. The estimates in this paper are broadly comparable to those in Roehner and Shiue (2000), Keller and Shiue (2007), and Shiue and Keller (2007), who evaluate market performance using grain prices from the 18th century. Taken together, the evidence suggests that Chinese markets achieved only limited development by the late Qing period. However, my findings diverge from those of Li (2000), who analyzes grain prices in Chihli (Hopeh) from 1738 to 1911. Li finds that while local markets within provinces became increasingly fragmented, provincial markets as a whole became more integrated with external markets—a trend they speculate continued after 1911. In contrast, my findings suggest that this pattern likely reversed during the early Republican period, as the collapse of central authority and growing political fragmentation led to deepening divisions between provinces. Although the early years of the Republican period show some potential for long-distance integration, the subsequent breakdown of the central government ultimately hindered market integration across provinces.

3.2 The Coal Industry

A History

China has a long history of using coal. Coal was mined in China as early as the 11th century (Hartwell, 1967), and the country was the world's largest producer and consumer of coal prior to the invention of the steam engine by James Watt in 1769. However, by the time of the modern era, China's coal industry had fallen behind.

Before 1870, there were very few coal mines, and coal mining remained small in scale. The government, fearing that large concentrations of unruly miners could threaten law and order, imposed strict restrictions on coal mining (Wright, 1980).

Between 1870 and 1895, the Qing government began to recognize the importance of coal as an energy source, and some government-supervised coal mines were developed in northern China as part of the Self-Strengthening Movement. However, all except the Kaiping coal mine eventually failed. The Kaiping mine was ultimately taken over by a British company after 1900 (Carlson, 1971).

A major turning point came in 1895, when the Treaty of Shimonoseki—signed after China's defeat in the First Sino-Japanese War—allowed foreigners to open mines in the interior. This was followed by the Sino-British Treaty of 1902 and the Sino-American Treaty of 1903, which together laid the foundation for foreign investment in China's modern mining industry (Wright, 1984). Foreign investors quickly responded to the opening of the sector, and between 1895 and 1912, several large coal mines, primarily in northern China, were developed by foreign interests (Thomson, 2003).

Despite the opening of the mining sector to foreigners, private domestic participation remained restricted. Without foreign backing or political connections, private enterprises continued to face great difficulty in obtaining mining licenses (Wright, 1980).

Another turning point came in the final years of the Qing dynasty. After 1906, the government began to relax restrictions on private enterprises, hoping they could compete with foreign investors. Following the collapse of the Qing in 1911, the economy experienced a wave of market liberalization. In most sectors, political control weakened, and private participation in industry and commerce grew (Wright, 1980).

In the coal industry, political connections remained important for the development of large mines. During the early Republican period, warlord connections helped secure capital, reduced "irregular" local taxes and facilitated access to transportation, especially railways. Rather than seizing mines directly through military force, warlords often joined new or existing mining ventures as partners.

In general, political connections were essential for overcoming entry barriers during the Qing, but their role later shifted toward providing financial support. This shift enabled the entry of "small mines" without political connections. During the early Republican era, abundant deposits near the surface allowed small mines to extract coal using very simple traditional techniques. While large coal mines were concentrated in northern China, small coal mines were widely scattered. Cases of merchants opening coal mines became more prominent, particularly in regions south of the Yangtze River (Wright, 1980; Wright, 1984), closer to traditional commercial centers such as Shanghai and Canton. In principle, all mines were required to obtain government licenses, but small mines were often unlicensed and operated illegally without government oversight (Thomson, 2003).[1]

The entry of small coal mines significantly changed the coal markets. It decentralized coal production and gave rise to competitive local markets. The raw coal produced by small mines generated intense competition for large mines (Thomson, 2003; Wright, 1980). In some regions, small mines even dominated to such an extent that they blocked the entry of large mines by keeping market prices exceptionally low (Wright, 1980).

Coal Production and Consumption

China has abundant coal deposits. Although at that time most large coal mines were located in northern China, coal deposits were widely distributed across the country, and during the early Republican period, every province produced some coal (Yang, 1993; Wright, 1984). Coal mines varied significantly in terms of size and production technology. Smaller mines typically employed traditional, unmechanized methods, while only a few large mines in northern China utilized modern, mechanized technologies (Wright, 1984).

Technology affected the quality of coal produced, which in turn influenced its possible uses.[2] Coal came in two broad varieties "raw" and "refined." Raw coal was primarily used for heating and other household needs, whereas refined coal was used mainly for industry.

In my data sources described in the next section, raw coal and refined coal are listed separately. I focus on raw coal prices for several reasons. First, as noted by Pomeranz (2000), raw coal was important despite not being directly used in modern industry. Second, small coal mines could only produce raw coal. Raw coal was produced in many locations, whereas refined coal was produced only in a few large, modern coal mines. Finally, raw coal was in widespread demand across the country.

[1] According to Thomson (2003), these small mines accounted for roughly one-quarter of total coal output (*The Chinese Coal Industry: An Economic History*, Routledge, p. 10).

[2] For example, Wright (1984), pp. 51–52, argues that coal produced by traditional methods was unable to meet the quality requirements for steamships.

Despite the growth in modern industrial usage, raw coal continued to dominate overall coal consumption.[3] Focusing on raw coal helps avoid complications related to differences in coal quality and alleviates concerns about strategic entry by modern factories which could create endogenous demand shocks.

Coal Transport

The three most commonly used methods for transporting coal within China were railways, waterways, and manpower. As in many countries, railways were the most efficient means of internal coal transport. The cost of railway transport was less than one-fifth that of other forms of land transport, and coal shipments occupied a significant share of railway capacity (Thomson, 2003). Water transport was also widely used, whether along the coast, major rivers (e.g., the Yangtze), or smaller rivers—particularly in the southwest (Thomson, 2003). Finally, manpower and carting was perhaps the least desirable method, yet due to China's limited development in modern transportation, it remained common during the Republican period. There are records of households traveling to nearby coal mines to carry back coal for fuel by human or animal power.[4] However, manpower was not feasible for long-distance coal trade. Wright (1984) estimates that in 1913, the economic radius for cart-based coal transport was approximately 75 kilometers, whereas for railways it extended beyond 500 kilometers, or a quarter of the range of distances in China. These figures offer a sense of the potential scale at which coal markets could be integrated.

Coal v.s. Grain

The literature usually uses grain prices to study market integration due to several advantages that grain has. First, grain was a necessity consumed by every household, resulting in widespread and stable demand. Second, grain was a relatively homogeneous good, with some but limited quality variation, making prices comparable across regions. Third, it was possible (though not necessarily the case) to transport grain over relatively large distances. Finally, grain cultivation was primarily affected by random weather patterns, which created heterogeneous local supply shocks. Estimates of market integration using grain prices essentially test how well these random local supply shocks were absorbed through trade.

[3]According to Wright (1984), p. 74, Table 21, rural use accounted for 43.2% and urban commercial and household use of raw coal for 13.2% in 1915; the corresponding figures for 1923 were 33.3% and 12.1%.

[4]Wright (1984), pp. 66–67.

As discussed above, raw coal possesses the first three of grain's four virtues. It was widely consumed during the Republican period and produced in every province, though not necessarily in every county. By focusing on raw coal, coal quality is more consistently controlled, ensuring that prices are comparable across regions. Coal could also be transported via multiple modes of transportation. Finally, although coal does not share grain's final feature, it can provide unique insights into market integration.

The supply of grain was constrained by the finite amount of arable land and became increasingly dependent on weather conditions once most cultivable land was in use. In contrast, the supply of coal was largely determined by human decisions rather than random weather shocks. At the time, China's coal deposits remained largely unexploited. Coal supply primarily depended on the deliberate decision to open new mines. This feature makes it meaningful to examine the drivers of supply shocks in the coal market—that is, the factors influencing the entry decisions of small coal mines. The strategic entry of local producers, in turn, affected price correlations across markets.

3.3 Data

I compile coal price and output data based on the *Nongshang Tongji Biao*. The *Nongshang Tongji Biao* (Survey of Agriculture and Commerce) was a series of annual reports issued by the Ministry of Agriculture, Industry, and Commerce during early Republican China (available for 1912–1919). County officials were required to follow the ministry's prescribed guidelines to collect data, which was then reported to the provincial authorities. The provinces subsequently compiled and submitted the aggregated data to the central government. The *Nongshang Tongji Biao* covered a wide range of information, including industrial products, mineral outputs, and commercial guilds. For most commodities, it reported both the quantity produced and the estimated value provided by local officials based on local prices. The survey used the metric ton and the silver dollar (yin yuan) as units of measurement.[5]

Given its rich information, the *Nongshang Tongji Biao* was unarguably one of the most important Chinese-sourced economic statistics for studying early Republican China. However, it has been underutilized in the literature due to some limitations. First, because the data were reported by local officials and it is clear not all of

[5] 1 yin yuan = 24.8798g silver.

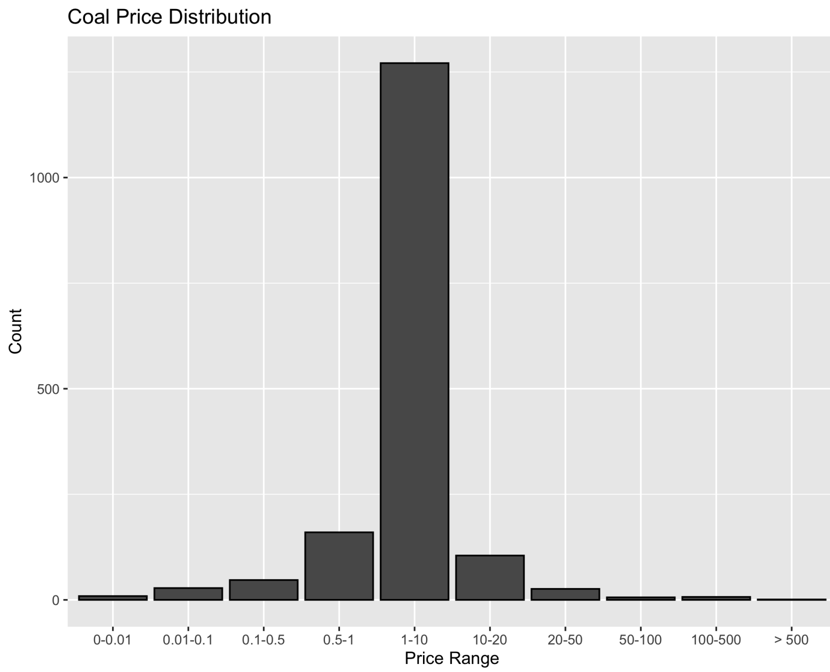


Figure 3.1: Coal Price Distribution

them used the units prescribed. As a result, some counties report producing tens of millions of tons of coal in a single year. These implausible figures are likely the result of incorrect units—perhaps mistakenly using *jin* instead of tons.

For coal prices, the vast majority of data points fall within a reasonable range. Figure 3.1 shows that the majority of counties—specifically, $1,534$ out of $1,660$ observations—reported coal prices between 0.5 and 20, despite the existence of extremely small values (e.g., 1.4×10^{-6}) and extremely large values (e.g., 2848). In this paper, I adopt a simple approach by dropping all price observations outside the 0.5–20 range.[6] This approach assumes that all outliers are random errors, so removing their does not bias the empirical results. Future research could adjust these values by making assumptions about the units used by local officials.

Second, the *Nongshang Tongji Biao* is incomplete, particularly for the years after 1915. To begin, because the survey focused on local production, if a place did not produce a particular commodity, the price for that commodity would be unavailable for that location.[7] There were also missing observations, because the statistics were reported by provincial governments to the central authority, after Yuan Shikai

[6]Reasonable adjustments to the upper bound and the lower bound may affect the magnitudes of the estimates, but the main findings remain consistent.

[7]Even if a place produced a certain commodity, its data may still be missing if local officials failed or were unwilling to collect and report it to the higher-level government.

declared himself emperor, many provinces, especially those in the south, declared independence and consequently ceased reporting data.

Table 3.1 presents the summary statistics of coal prices after dropping the outliers. Despite the decline in the number of observations over the years, in 1919, there were still 119 counties across 11 provinces reporting their data. Moreover, most provinces ceased reporting due to political reasons rather than factors related to market performance. These arguments alleviate the concerns about potential selection issues.

Year	Mean	Median	SD	Min	Max	N	# Prov
1912	4.16	3.42	3.44	0.80	19.10	191	16
1913	3.30	2.54	2.87	0.51	19.04	218	17
1914	3.27	2.23	3.10	0.51	19.04	259	21
1915	4.19	2.92	4.22	0.52	19.10	187	19
1916	4.46	3.01	4.30	0.51	19.35	186	19
1917	4.23	3.09	3.62	0.50	19.19	194	17
1918	3.92	2.92	3.17	0.51	19.35	181	15
1919	3.71	2.96	3.19	0.50	15.47	118	11

Table 3.1: Summary Statistics by Year, Coal Prices, 1912-1919

Table 3.2 presents summary statistics for each province. Compared to grain prices during 1723–1735, as reported in Table 1 of Keller and Shiue (2007), coal prices exhibit somewhat higher variation within provinces. This likely reflects the fact that grain cultivation was heavily influenced by weather, which tended to affect large regions (like provinces) uniformly. The last column in Table 3.2 reports the average output across all provinces. Consistent with the literature, provinces in Northern China, such as Hopeh and Shansi, produced more coal. Nevertheless, all provinces engaged in coal production during this period.

3.4 Interregional Integration

3.4.1 Correlation Length

The first approach I adopt is correlation length, adopted by Roehner and Shiue (2000). My dataset is a short panel of only eight years, but each year contains more than one hundred observations. I aim to estimate the level of spatial integration and compare it across years. This approach is revised to focus on spatial autocorrelation, which aligns better with both the structure of the data and the objective of the analysis.

Suppose I have N locations. I randomly index them by $1, 2, 3, \ldots, N$ and keep the

Province	Mean	Median	SD	Min	Max	Average Output (tons)
Yunnan	2.82	2.21	1.63	0.52	6.00	33208
Kirin	4.16	3.31	3.15	1.20	16.72	16536
Szechwan	3.91	3.33	2.39	0.56	15.28	654103
Fengtien	3.77	3.50	2.32	0.80	12.27	2665835
Anhwei	4.75	4.30	3.03	1.25	17.24	43913
Shantung	3.55	3.31	2.01	0.71	10.10	427715
Shansi	1.88	1.48	1.55	0.50	12.08	1409806
Kwangtung	6.00	5.26	3.11	1.18	10.84	56404
Kwangsi	4.52	2.07	4.56	1.00	13.00	4522
Sinkaing	8.62	7.30	5.12	0.59	19.35	1988894
Kiangsu	5.03	4.60	1.47	2.29	7.00	58388
Kiangsi	3.62	2.86	2.60	0.58	16.00	705641
Honan	2.19	1.60	2.45	0.54	18.00	747976
Chekiang	8.02	7.98	1.90	5.00	11.26	1927
Hupeh	3.37	2.89	1.74	0.60	7.85	128386
Hunan	5.16	5.03	3.55	0.76	15.00	609178
kansu	4.57	3.87	3.52	0.51	16.00	52520
Chihli (Hopeh)	3.52	3.11	2.17	0.63	15.47	3275208
Fukien	3.08	2.71	2.69	1.36	14.12	28725
Keichow	2.33	1.68	2.15	0.52	12.71	25019
Shensi	8.63	8.45	6.78	0.52	19.35	45700
Heilungkiang	14.12	14.00	2.61	11.57	16.80	2432

Table 3.2: Summary Statistics by Province, 1912-1919

indexing consistent throughout. The geographic distance between location i and location j is denoted by d_{ij}. I group observations into distance bins of 50 km. For each bin, I calculate the correlation among all pairs of observations whose distances fall within that range:

$$B_k = \{(i, j) : d_{ij} \in [a_k, b_k] \text{ and } i < j\}$$

and

$$\rho(B_k) = corr(\{p_i\}_{(i,j)\in B_k}, \{p_j\}_{(i,j)\in B_k}).$$

Here, B_k is the kth distance bin, containing all location pairs with distances between a_k and b_k. I always place the location with the lower index first in each pair.[8] I then compute the Pearson correlation for each bin.

Figure 3.2 shows the trend in price correlation over distance. In general, the correlation decreases as distance increases.[9] However, beyond approximately 400 km, the correlation begins to oscillate around zero. After this distance, the correlation

[8]Note that a lower index does not imply a lower coal price.

[9]Here, distance is binned in 200 km intervals for clearer visualization.

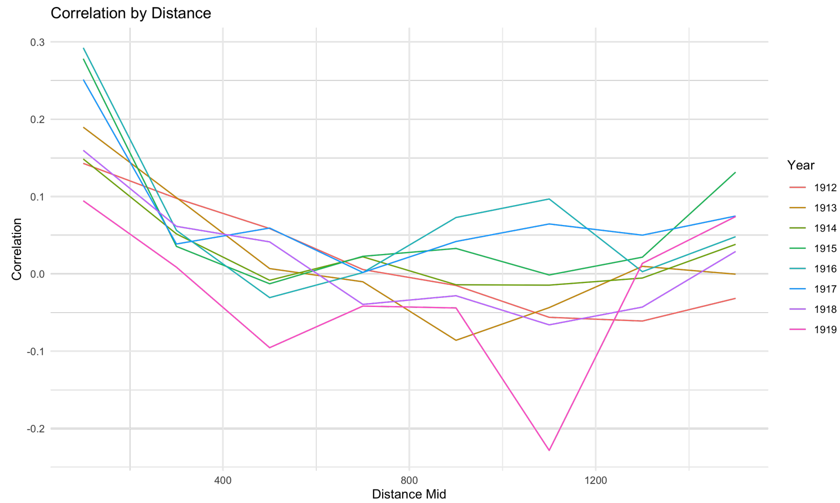


Figure 3.2: Price Correlation by Distance

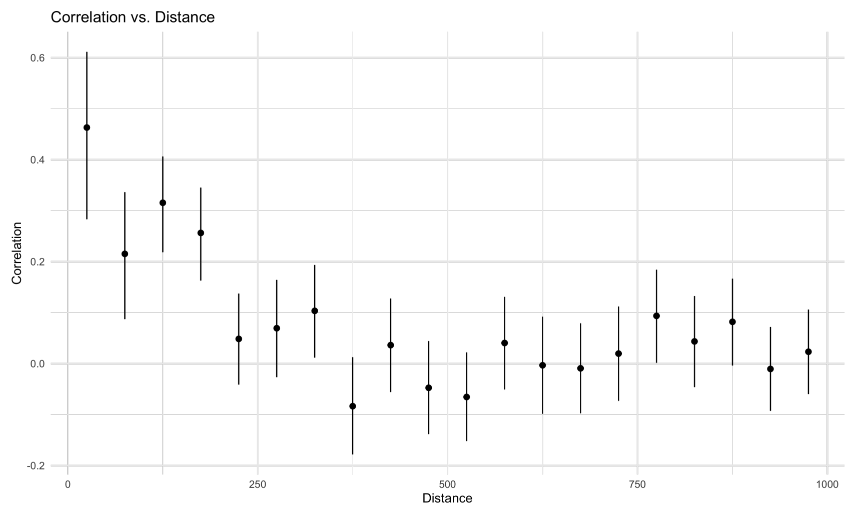


Figure 3.3: Correlations and Confidence Intervals by Distance Bin, 1915

becomes highly variable and uninformative. Accordingly, only pairs within $1,000$ km are included in the estimation of correlation length.

The correlation length, denoted by ξ, is defined by the following formula:

$$\rho(d_k) = e^{-d_k/\xi}, \quad \text{where } d_k = (a_k + b_k)/2. \tag{3.1}$$

The dependent variable $\rho(d_k)$ represents the correlation between prices in the kth distance bin, and d_k is the midpoint of the corresponding distance bin. Figure 3.3 presents the Pearson correlation coefficients and their confidence intervals for each distance bin in 1915. The parameter ξ is the key quantity to be estimated, and I estimate it using nonlinear least squares (NLS).

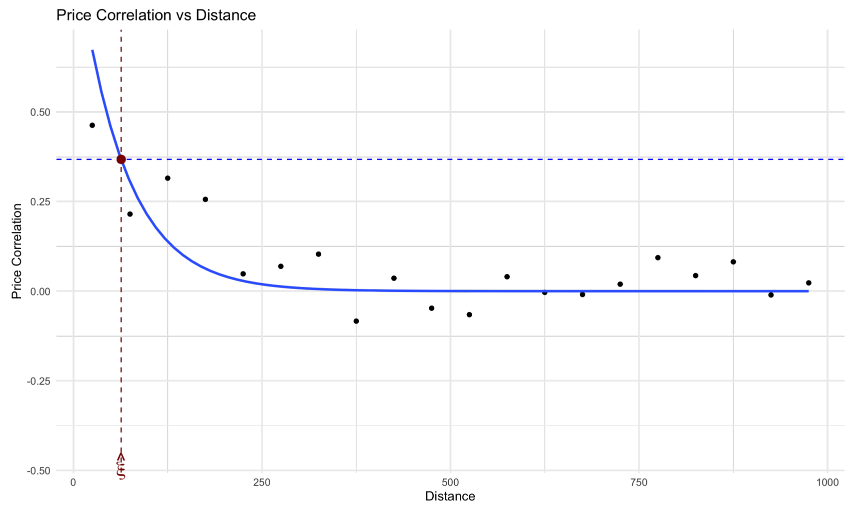


Figure 3.4: Coal Price Correlation v.s. Distance, 1915

The coefficient ξ represents the characteristic distance over which price correlations decay. Specifically, it is the distance at which the correlation drops to $e^{-1} \approx 0.37$. A larger ξ implies a slower decay of correlation with distance, indicating that prices remain correlated over longer distances—a sign of stronger market integration. Figure 3.4 provides a visualization of ξ in 1915, when the correlation length is 63.26 km.

The correlation length captures the spatial correlation of prices, making it particularly suitable for my dataset, which consists of a relatively short panel (only eight years) but many observations per year. Moreover, the correlation length is independent of the absolute level of prices, making it ideal for comparing different markets (Roehner and Shiue, 2000). This feature allows me to track changes in interregional market integration over time and to compare market performance in China with that of other countries or with China during other historical periods.

Figure 3.5 presents the results of the estimated correlation length. In 1912, the correlation length was 13.4 km.[10] The correlation length increased rapidly between 1912 and 1916. In 1916, the correlation length triples compared to 1912, reaching its maximum of nearly 75 km. This distance is also the economic radius of cart-based coal transport estimated by Wright (1984). Even at its best, interregional market integration in China never extended beyond the limits of animal-powered transport. This is perhaps unsurprising, given the limited development of modern

[10] As a reference, the correlation length in Jiangsu was 4.8 km during 1742–1795, while in France it was 16.5 km during 1756–1790, according to Roehner and Shiue (2000) using grain prices.

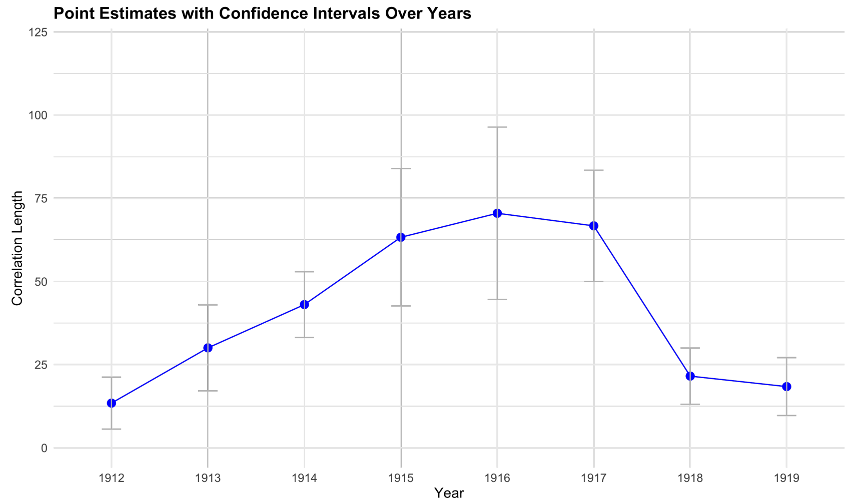


Figure 3.5: Correlation Length, 1912-1919

Figure 3.5 presents the point estimates and confidence intervals for the correlation length over the period 1912–1919. The point estimates are obtained using NLS, while the confidence intervals are estimated via bootstrap using the delta method.

transportation infrastructure at the time. Moreover, spatial integration began to decline after 1916, coinciding with the start of the country's political disintegration.

I then estimate the correlation length by region using data from 1914 and 1915. The results are presented in Figure 3.6. Two important takeaways emerge. First, market integration varied significantly across regions. Correlation length is significantly higher in Manchuria than in the central inland, northern interior, and southwest regions, likely due to its relatively developed railway system, benefited from strategic investments by Russia and Japan. This piece of results also raises a concern about our previous estimation. Because some provinces stopped reporting data in later years, the observed trend in Figure 3.5 may be driven by an unbalanced sample. In the Appendix 3.A, I alleviate this concern by re-estimating all key specifications using a more balanced sample, dropping provinces with substantial missing data. Second, most large coal mines were located in the Northern Interior (e.g., the Kaiping coal mine in Chihli). However, the presence of large coal mines did not necessarily translate into better coal market integration. One possible explanation is that these mines were situated inland, often far from low-cost transport networks. Again, natural endowment alone does not guarantee an economic advantage.

In Appendix 3.B, I present additional estimates of correlation length that include coal prices at treaty ports. One point worth noting is that the CMC trade reports did not distinguish between raw coal and refined coal. Given the context at the time, China likely imported high-quality coal intended for industrial use, so coal

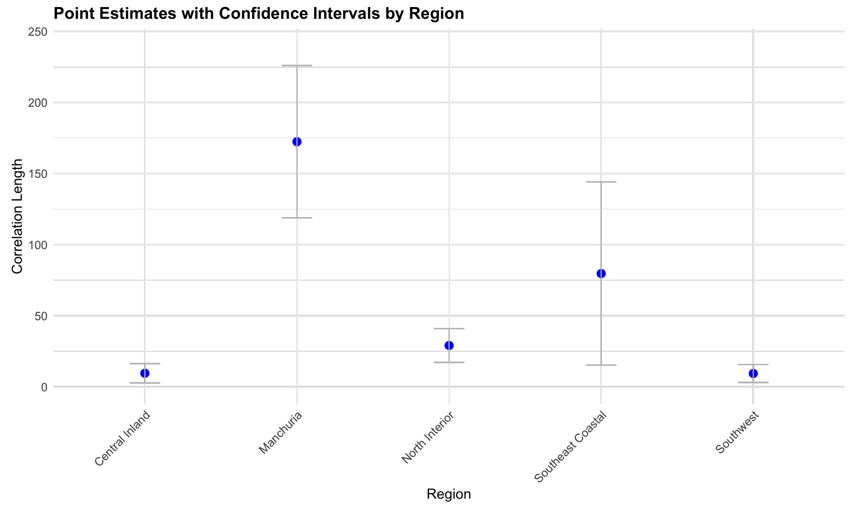


Figure 3.6: Correlation Length by Region 1913
Figure 3.6 presents the point estimates and confidence intervals for the correlation length by region using data from 1914 and 1915. The point estimates are obtained via nonlinear least squares (NLS), and the confidence intervals are estimated through bootstrapping using the delta method. The "Northern Interior" region includes Chihli (Hopeh), Honan, Shantung, Shansi, Shensi, and Kansu. "Manchuria" includes Heilungkiang, Kirin, and Fengtien. "Southwest" includes Szechwan, Yunnan, Kweichow, and Kuangsi. "Central Inland" includes Hunan, Hupeh, Kiangsi, and Anhwei. "Southeast Coastal" includes Kiangsu, Chekiang, Fukien, and Kwangtung.

prices at treaty ports may not be fully comparable to the raw coal prices in our main dataset. Nevertheless, I find that incorporating treaty port prices significantly improves the degree of estimated market integration, particularly during periods of political instability.

3.4.2 Global, National, and Local Shocks

The second measure of market performance follows Keller and Shiue (2007) by distinguishing between global, national, and local shocks that influenced local prices. The intuition behind this approach is that, in fully integrated markets, local shocks should have little impact on local prices, as such shocks should be fully absorbed by the entire economy. Therefore, within a regression framework, I examine the extent to which the local price P_{it} is determined by the global price P_t^G, the national price P_t^N, and the local price P_{it}^L.

The global price P_t^G is proxied by the price of coal in Shanghai, the largest treaty port, reported in the Chinese Maritime Customs (CMC) trade reports.

The national price is defined by

$$P_t^N = \frac{V_t^N}{Q_t^N},$$

where V_t^N is the total value of coal produced in Year t and Q_t^N is the total quantity.

I further define the in-Province price and out-Province price by

$$P_{it}^{In} = \frac{V_{it}^{In}}{Q_{it}^{In}} \text{ and } P_{it}^{Out} = \frac{V_{it}^{Out}}{Q_{it}^{Out}},$$

where V_{it}^{In} and Q_{it}^{In} are the value and the quantity of coal produced in the province where County i is located during Year t; V_{it}^{Out} and Q_{it}^{Out} are the value and the quantity of coal produced outside the province where County i is located during Year t.

Finally, the near price and far price are defined by

$$P_{it}^{Near} = \frac{V_{it}^{Near}}{Q_{it}^{Near}} \text{ and } P_{it}^{Far} = \frac{V_{it}^{Far}}{Q_{it}^{Far}},$$

where V_{it}^{Near} and Q_{it}^{Near} are the value and the quantity of coal produced within C km of County i; V_{it}^{Far} and Q_{it}^{Far} are the value and the quantity of coal produced farther than C km from County i during Year t. C refers to different cutoffs.[11]

Table 3.3 presents the regression results for the full sample. Columns (1) and (2) show that local prices were significantly affected by both global and national prices. The coefficient on the national price is 0.293.[12] The coefficients on global and national prices are similar. This similarity is unsurprising, as the global price was highly correlated with the national price. After several decades of integration into the global market following the opening of the treaty ports, such correlation is to be expected. Column (3) shows that local prices were significantly correlated with in-provincial prices, but not with out-provincial prices after controlling for in-provincial prices. This echoes the findings in the previous section: the correlation length was not long enough to extend beyond provinces, especially considering that Chinese provinces were geographically large. Finally, the last column indicates that local prices were significantly affected by both the near price and the far price. However, both coefficients are small. The cutoff for "Near," 700 km, is much larger

[11] The cutoff 700 km is used by Keller and Shiue (2007).

[12] As a reference, the coefficient on the national price is 0.476, as estimated by Keller and Shiue (2007) using grain prices from 1723–1735, while the coefficient is 0.974 for China during 1986–1993.

than the typical size of a province, so the near price has far less explanatory power for local prices than the in-provincial price. The far price may partially reflect the influence of the national (or global) price and thus retains some explanatory power.

Table 3.3: Global, National, and Local Shocks, Coal Prices, 1912-1919

Dependent Variable:	log(Price)			
Model:	(1) Global	(2) National	(3) Province	(4) Distance
Variables				
log(Global Price)	0.2699***			
	(0.0517)			
log(National Price)		0.2934***		
		(0.0642)		
log(In-Province Price)			0.4768***	
			(0.1268)	
log(Out-Province Price)			0.1145	
			(0.0753)	
log(Near Price)				0.1636**
				(0.0731)
log(Far Price)				0.1052**
				(0.0467)
Fixed-effects				
Province	Yes	Yes	Yes	Yes
Fit statistics				
Observations	1,534	1,534	1,534	1,534
R^2	0.31268	0.31474	0.36173	0.31254
Within R^2	0.01441	0.01737	0.08475	0.01421

Clustered (Province) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

Table 3.4 presents the results separately for the first half of the sample (1912–1915) and the second half (1916-1919). During the first period, the political situation remained relatively stable. On December 12, 1915, the first president of China declared the restoration of the hereditary monarchy. Shortly thereafter, China fragmented into regions controlled by regional military governors. The second half of the sample represents a period of political disintegration.

Compared to the full sample results, the first period shows evidence of stronger market performance, while market performance significantly declined in the second period. Column (1) of Table 3.4 shows that the coefficient on the national price nearly doubled compared to the full sample. However, it loses all significance during the second period as shown by Column (2). Column (3) indicates that in addition to in-province correlations, local prices were also significantly correlated with prices outside the province during the first period. However, as shown in Column (4), in the second period, not only does the coefficient on the in-province price become smaller, but the out-of-province price also loses all explanatory power. Finally, the near/far price cutoff in this table is 700 km. In the first period, the near price remains significantly correlated with the local price, and even the far price retains some explanatory power, as shown in Column (5). In contrast, during the second period (Column (6)), both near and far prices lose their explanatory power. Figure 3.7 further illustrates the estimates on near prices using different distance cutoffs. The figure shows that in the second period (green), the near price loses its explanatory power at distances below 400 km, whereas in the first period (blue), it remains statistically significant even at distances up to 1000 km.

These results all indicate that, following the collapse of the Qing dynasty, Chinese markets began to integrate rapidly under the new, more liberalized institutional environment, showing a trend toward long-distance market integration. However, this trend came to a halt with the fall of the central government. Compared to the first half, price correlations decreased at all levels in the second half. There was no significant price integration beyond the provincial level. These findings indicate that markets were quick to respond to changes in institutional environments. They also suggest that, had China remained politically unified, market integration could have continued to grow. Moreover, had the Qing created similar market liberalization, the growth observed during 1912–1915 could have occurred earlier and been more sustained.

3.4.3 Cointegration

The final approach I adopt is the cointegration method from Shiue and Keller (2007). In time series analysis, cointegration suggests that although individual series may drift in the short term, they tend to move together over the long run. A higher degree of cointegration, therefore, indicates stronger price integration between markets. However, results using this approach should be interpreted with caution due to the short length of time ($T = 8$) in my sample.

In my dataset, 21 counties report prices for all eight years. Therefore, I restrict my sample to these 21 counties. These counties are all located in areas surrounding Bei-

Table 3.4: National and Local Shocks, 1912-1915 and 1916-1919

Dependent Variable:	log(Price)					
Model:	(1) 1912-1915	(2) 1916-1919	(3) 1912-1915	(4) 1916-1919	(5) 1912-1915	(6) 1916-1919
Variables						
log(National Price)	0.5398**	0.0706				
	(0.2222)	(0.1183)				
log(In-Province Price)			0.5929***	0.3745**		
			(0.1007)	(0.1457)		
log(Out-Province Price)			0.3000***	-0.0703		
			(0.0555)	(0.0988)		
log(Near Price)					0.2887***	-0.0185
					(0.0925)	(0.0725)
log(Far Price)					0.1822	0.0244
					(0.1679)	(0.0709)
Fixed-effects						
Province	Yes	Yes	Yes	Yes	Yes	Yes
Fit statistics						
Observations	855	679	855	679	855	679
R^2	0.28552	0.38925	0.34986	0.40761	0.28922	0.38874
Within R^2	0.01838	0.00122	0.10678	0.03126	0.02346	0.00039

Clustered (Province) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

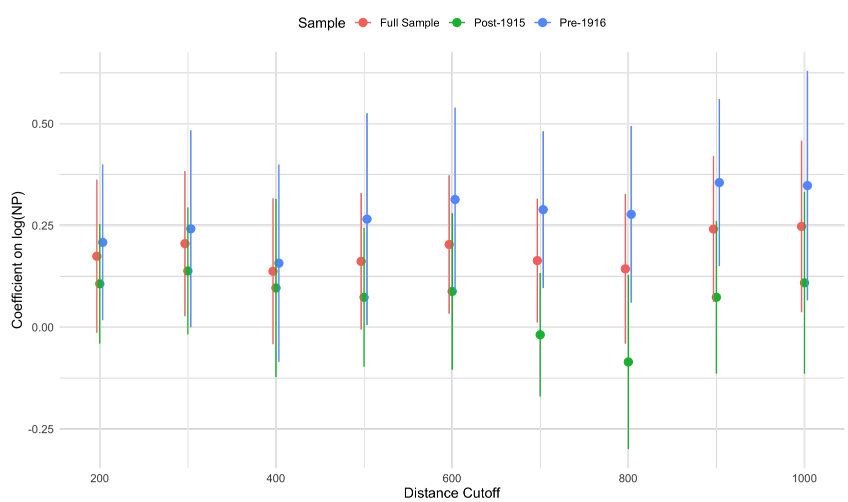


Figure 3.7: Near Price Correlations Using Different Distance Cutoffs

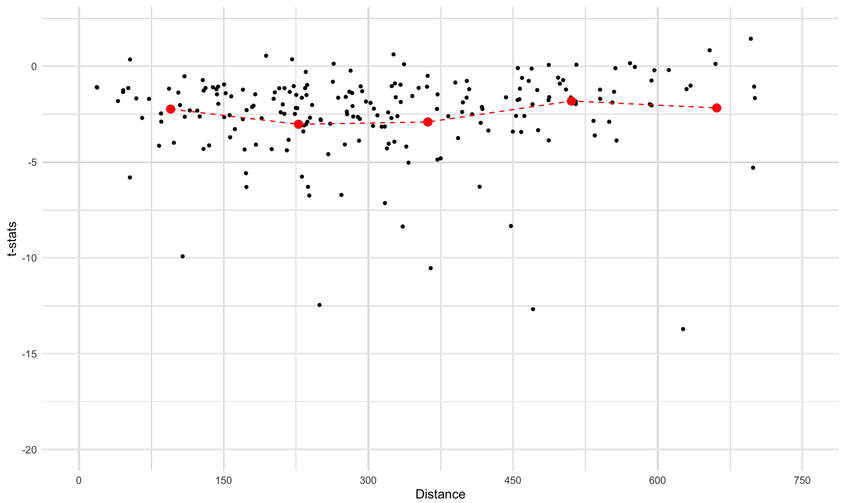


Figure 3.8: Cointegration

jing, where the central government still maintained influence even as many southern provinces declared independence. Rather than reflecting overall market performance in China, the results in this subsection should be interpreted as representative of a specific subregion within China.

For every two counties, I first run the following regression:

$$P_{1t} = \beta_0 + \beta_1 P_{2t} + \epsilon_t$$

and then test $\hat{\epsilon}_t$ for stationarity using an Augmented Dickey-Fuller (ADF) regression. The smaller the t-statistic from the ADF test, the stronger the evidence for cointegration between P_1 and P_2.

Figure 3.8 presents the results. The black dots represent the test statistics from the ADF regression for each pair of series, while the red dots indicate the average within each distance bin. The results are comparable to those reported in Figure 4 of Shiue and Keller (2007), which analyzes grain markets in China's provincial capitals during 1742–1795. In a more developed market, an upward trend is typically observed, indicating that cointegration decreases with distance.[13] However, the results shown here suggest that overall market performance in China remained quite limited.

3.5 Local Supply

Market integration occurs when trade costs between two markets decline. However, trade is not the only mechanism that drives price convergence. During the early Republican period, the entry of small producers created supply shocks in local markets,

[13] As demonstrated by the estimates for European cities in Figure 4 of Shiue and Keller (2007).

which also influenced the price trends observed. It is therefore important to identify these supply shocks and understand the entry decisions of small coal mines. The endogenous nature of supply shocks in local coal markets has important implications for both the interpretation of previous estimates and our broader understanding of the coal industry.

Shocks in the Market

Define P as the equilibrium price and Q as the quantity of *local* production.

In the simplest equilibrium setting, a demand shock (i.e., a rightward or leftward shift of the demand curve) results in both price and quantity increasing or decreasing together. In contrast, a supply shock leads to a change in quantity and an opposite change in price, either an increase in quantity with a decrease in price, or a decrease in quantity with an increase in price.

Following this logic, I define that a county appears *as if* it experiences a *positive local supply shock* if its price decreases while local production increases $(P \downarrow, Q \uparrow)$. Similarly, a *negative local supply shock* is defined by $(P \uparrow, Q \downarrow)$; a *positive demand shock* by $(P \uparrow, Q \uparrow)$; and a *negative demand shock* by $(P \downarrow, Q \downarrow)$.

Two points are worth noting. First, these are referred to as *local* shocks because Q denotes *local* production rather than the total market quantity in equilibrium. Since trade is possible, Q may differ from the equilibrium market quantity. Second, the term *as if* is used because, as explained in the following paragraphs, appearing to experience a shock does not necessarily imply that a shock has actually occurred in the local market; rather, it may result from shocks in other markets that are transmitted through trade.

Now consider two counties, A and B, that trade with each other at zero trade cost. In the closed-economy equilibrium, assume without loss of generality that $P_A > P_B$. Once the two counties begin to trade, County B exports to County A, and in equilibrium, $P_A = P_B$. Suppose County B then experiences a positive supply shock (which shifts its supply curve to the right); as a result, P_B decreases, and in the new equilibrium, P_A also decreases because the condition $P_A = P_B$ must always hold. This lower P_A is associated with a decrease in County A's local production, Q_A. Note again that Q refers to *local* production rather than the market equilibrium quantity. Thus, a positive supply shock in County B will make it appear as though County A has experienced a negative demand shock, i.e., $(P_A \downarrow, Q_A \downarrow)$.

Appendix 3.C provides a comprehensive discussion of all possible cases. In summary, if one county experiences a positive (negative) demand shock, the other county will also appear to experience a positive (negative) demand shock. In contrast, if one county experiences a positive (negative) supply shock, the other county will behave as if it experienced a negative (positive) demand shock. No matter what one county experiences, the other county will always appear to experience a local *demand* shock. Therefore, when we observe a local supply shock in the data, it must reflect an actual local supply shock rather than effects transmitted through trade from elsewhere. When we observe what appears to be a demand shock, it may reflect either a true local demand shock or the effect of shocks from other counties transmitted through trade.

Supply Shocks

Figure 3.9 presents the number of counties that appeared to experience a supply or demand shock during the period 1913–1919. The figure shows that in every year, the number of counties that appeared to experience a supply shock always exceeded those that appeared to experience a demand shock. Moreover, this difference should be interpreted as a lower bound, given the logic discussed in the previous paragraph. The evidence indicates that the supply side plays an important role in shaping the market outcomes. As emphasized previously, the supply side reflects deliberate choices.

Figure 3.D3 further illustrates the two types of shocks observed in Shansi, one of the largest coal-producing provinces in China during 1913 to 1919. This figure confirms the logic discussed above. Since supply shocks induce responses in other locations that appear as if they were demand shocks, counties that appear to experience demand shocks are likely spatially entangled with those that experience supply shocks. Moreover, the figure shows that supply shocks were geographically dispersed and varied across years.

I then examine why positive supply shocks occurred in particular markets in specific years. These shocks likely reflect the entry of small coal mines. Consider a Probit regression:

$$Positive\_Supply\_Shock_{i,t} \sim \log(P_{i,t-1}).$$

where the LHS is a binary indicator for whether a county experiences a positive supply shock ($Q \uparrow, P \downarrow$), and the RHS measures the price level in the previous year.

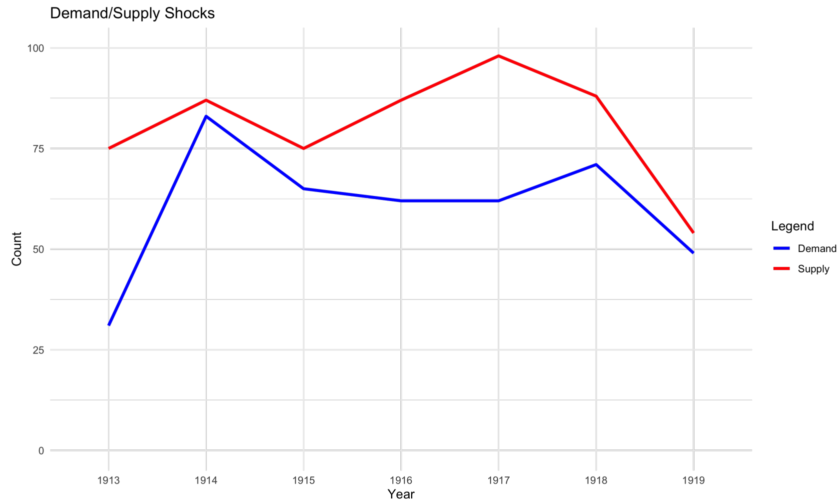


Figure 3.9: Demand/Supply Shocks

For each prospective mine, it will enter if and only if

$$\left\{ \max_{Q_1, Q_2, \ldots, Q_T} \quad \sum_{t=1}^{T} (1+r)^{-(t-1)} \left(P_t Q_t - C(Q_t)\right) \text{ s.t.} \sum_{t=1}^{T} Q_t = \bar{Q} \right\} > F.$$

Here, Q_t denotes the amount of coal produced in each year, subject to a fixed deposit constraint $\bar{Q}$. P_t is the coal price in each period, and $C(Q)$ represents the cost of producing quantity Q. For a producer to enter the market, the total discounted profits must exceed the sunk costs. While I do not explicitly solve this optimization problem, the key idea is that all future prices P_t are unknown and must be predicted based on the previous price. If the previous local market price was high, producers would likely anticipate continued high prices and thus be more likely to enter.

The absolute price level on the RHS can also be replaced with $\log(P_{t-1}^{\text{Relative}})$, defined as the county's price relative to the provincial average. A higher relative price indicates not only a high local price but also weak integration with surrounding areas. In such counties, local producers faced less external competition and were therefore more likely to enter.

Table 3.5 reports the results of the Probit regressions. Column (1) shows that a higher local price indeed provided an incentive for local producers to produce more. Column (2) shows that the effects being even stronger if the county was poorly integrated with other counties in the province. The results remain robust when local prices are normalized by the national average ($\frac{P_{it}}{P_t^N}$) to account for macro-level price changes, as shown in Table 3.A2.

These results have important implications. First, they suggest that positive supply shocks were more likely to occur in counties where coal prices had previously been high. In other words, private participants responded to market signals and strategically entered potentially profitable markets. Second, given the strategic entry of small coal mines, price convergence may have been driven not only by increased trade activity but also by local supply responses. In this sense, the improvements in market integration observed between 1912 and 1915 could have been driven by the entry of private producers after market liberalization. Finally, poor market integration was not necessarily a disadvantage, as it may have facilitated local mining development.

Table 3.5: Positive Supply Shock

Dependent Variable:	Positive Supply Shock	
Model:	(1)	(2)
Variables		
$\log(P_{i,t-1})$	0.6605***	
	(0.0773)	
$\log(P_{i,t}^{Relative})$		0.6556***
		(0.0651)
Fixed-effects		
Province	Yes	Yes
Year	Yes	Yes
Fit statistics		
Observations	1,012	1,012
Squared Correlation	0.11888	0.10882
Pseudo R^2	0.09824	0.09086
BIC	1,315.3	1,324.5

Clustered (Province) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

3.6 Conclusion

This paper provides insights into a key question in the "Great Divergence" literature: were the fuel constraints faced by commercial centers during the Qing purely a geographic accident, or were they also the result of unfavorable institutions?

To answer this question, it is not sufficient to examine the Qing period alone, as we cannot observe what would have happened under alternative institutional settings. In this paper, I adopt a retrospective counterfactual approach by examining coal markets in China during the early Republican period (1912–1919). The coal industry under the Qing was heavily restricted. Before 1870, there was virtually no coal industry in China, as only very few coal mines were permitted by the state. Even during the Self-Strengthening Movement (1870–1895) and after the mining sector was opened to foreign investment in 1895, private domestic participation in coal mining remained extremely limited. It was only in the final years of the Qing dynasty that restrictions on private involvement began to relax.

Using county-level coal price data, I estimate interregional market integration in China during the period 1912–1919. This was a crucial transitional period in Chinese history, beginning with the establishment of a new political system in 1912, followed by political disintegration after 1916. The estimates in this paper show that markets became more integrated between 1912 and 1915, but this trend reversed during 1916–1919 as political instability led to market fragmentation. Overall, markets remained poorly integrated spatially, with only some integration within provinces and a failure to achieve long-distance integration.

This paper highlights the importance of private initiatives in the development of the coal markets in China. The key difference between the Qing and the Republican coal industry is the possibility for private investors to open mines without political connections. Private participants responded to market signals. Their entry decentralized the coal production and created competitive local markets.

If the Qing had relaxed the restrictions on private participation earlier, the trend observed during 1912–1915 could possibly have taken place sooner and lasted longer. Although the entry of small coal mines probably could not have solved the entire energy problem, it might have reduced reliance on other energy sources that could have been used for industry in many places.

Finally, a similar trend is observed in China following the economic opening in 1978. A comparison between 1955 and 1985 in Figure 3.10 shows that after the opening up of the private sector, coal production in central and southern China, on average, grew more rapidly than in the traditional coal-producing regions of the North. This finding suggests that the pattern observed during the first wave of market liberalization in the early Republican period was likely repeated during the second wave after 1978—and may well be repeated in the future.

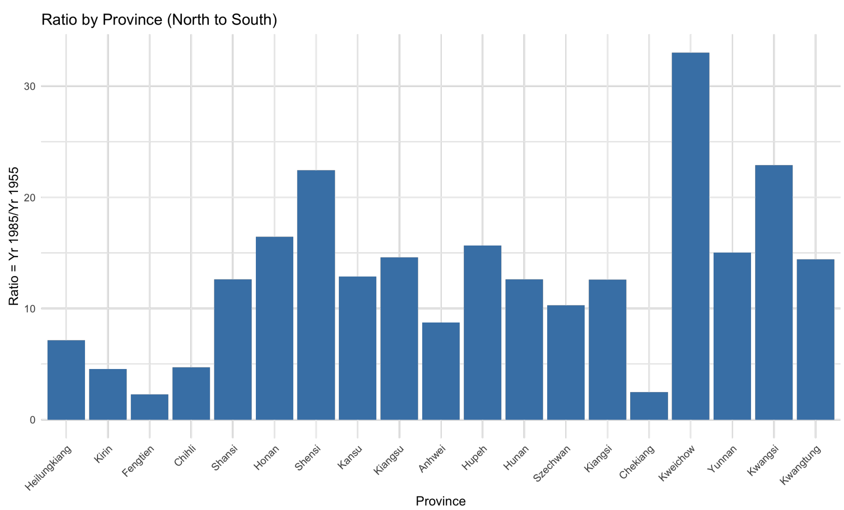


Figure 3.10: 1985/1955 Coal Production Ratio

3.A Robustness Checks

I created a more balanced sample by retaining provinces that reported data for at least two years during both 1912–1915 and 1916–1919. As a result, four provinces are dropped: Szechwan, Yunnan, Kweichow, and Heilungkiang. The main trend remains unchanged.

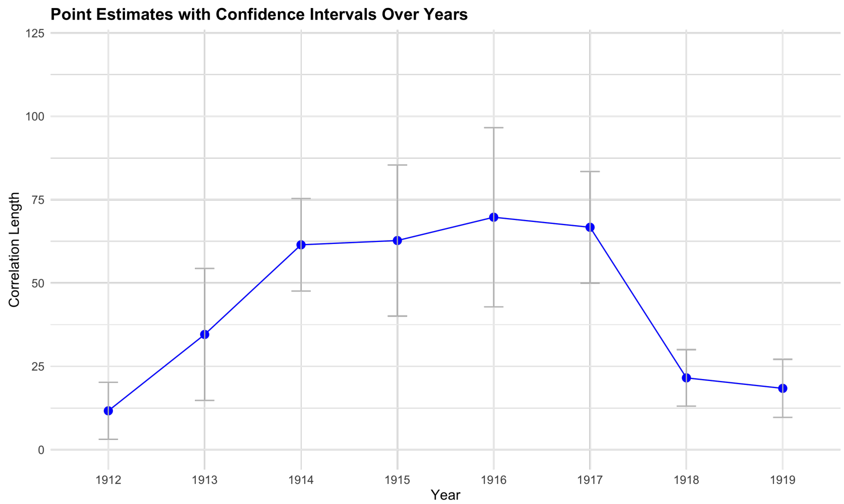


Figure 3.A1: Correlation Length, 1912-1919, Balanced

Table 3.A1: National and Local Shocks, Balanced

Dependent Variable:	log(Price)		
Model:	(1) Full	(2) 1912-1915	(3) 1916-1919
Variables			
log(In-Province Price)	0.4460***	0.5698***	0.3745**
	(0.1460)	(0.1349)	(0.1461)
log(Out-Province Price)	0.0962	0.2457**	-0.0704
	(0.0735)	(0.0954)	(0.0991)
Fixed-effects			
Province	Yes	Yes	Yes
Fit statistics			
Observations	1,284	607	677
R^2	0.37170	0.36466	0.40083
Within R^2	0.07552	0.09184	0.03126

Clustered (Province) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

In Table 3.A2, all prices, including those used to identify positive supply shocks, are replaced by prices normalized by the national average ($\frac{P_{it}}{P_t^N}$). This normalization controls for macro-level price changes across years.

Table 3.A2.

Table 3.A2: Positive Supply Shock, Normalized by National Average

Dependent Variable:	Positive Supply Shock	
Model:	(1)	(2)
Variables		
$\log(P_{i,t-1})$	0.6959***	
	(0.0544)	
$\log(P_{i,t-1}^{Relative})$		0.6597***
		(0.0563)
Fixed-effects		
Province	Yes	Yes
Year	Yes	Yes
Fit statistics		
Observations	1,012	1,012
Squared Correlation	0.15086	0.13987
Pseudo R^2	0.12903	0.11920
BIC	1,262.2	1,274.3

Clustered (Province) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

3.B Adding Trade Port Prices

I also add coal prices at treaty ports from the CMC reports. Details regarding the Treaty Port system and the CMC are elaborated in previous chapters and are therefore omitted here. One important note is that one *Hk. Tls* used in the CMC reports equals 37.8 grams of silver, whereas one *yin yuan*, as used in the *Nongshang Tongji Biao*, equals 24.8 grams of silver. Accordingly, I convert all prices to *yin yuan*.[14]

Figure 3.B2 further presents estimates that include prices at treaty ports. A comparison of the red and blue points shows that, on average, correlation lengths are higher when treaty port prices are included than when they are excluded. Notably, after 1916—when the central government collapsed—correlation lengths continued to increase in the estimates that include port prices. There are two interpretations. First, as argued in the previous chapters, import prices at treaty ports were driven by global supply factors, so prices in treaty port cities could be correlated, especially when some ports shared origin countries. Second, treaty ports were more developed due to stable Western institutions. These ports had spillover effects, which may have led to stronger price correlations with surrounding areas. Finally, nearly all treaty ports were located along major long-distance transportation routes, particularly waterways. Therefore, including them improved overall estimated market performance. Their advantages became particularly pronounced when the rest of the country was experiencing political instability.

However, the results in Figure 3.B2 should be interpreted with caution. In the CMC trade reports, raw coal and refined coal are not listed separately. It is generally believed that the coal imported by China was of higher quality, and a significant portion of it was used for industry.

[14] Raw coal and refined coal were not listed separately in the CMC reports. Imported coal was usually of higher quality. The average price of imported coal was also higher than that of locally produced raw coal.

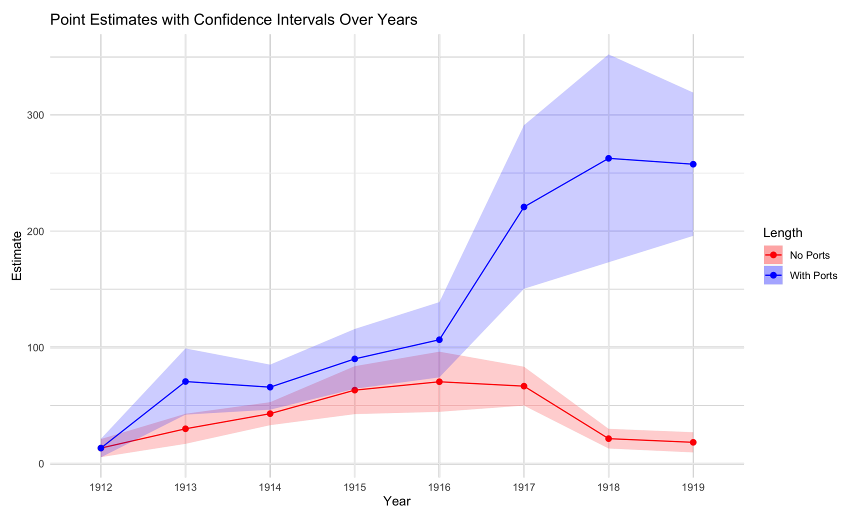


Figure 3.B2: Correlation Length, 1912-1919, with Treaty Ports

3.C Local Supply/Demand Shocks

- Remember that P refers to the market price, while Q refers to *local* production.

- Suppose two markets, A and B, trade with each other at zero trade cost. In the closed-economy equilibrium, assume without loss of generality that $P_A > P_B$. Once trade is open at zero cost, the equilibrium condition becomes $P_A = P_B$.

  – If Market B experiences a negative supply shock $(P_B \uparrow, Q_B \downarrow) \Rightarrow P_A \uparrow \Rightarrow Q_A \uparrow$, then $(P_A \uparrow, Q_A \uparrow)$, which makes it appear as though A has experienced a positive local demand shock.

  – If Market B experiences a positive supply shock $(P_B \downarrow, Q_B \uparrow) \Rightarrow P_A \downarrow \Rightarrow Q_A \downarrow$, then $(P_A \downarrow, Q_A \downarrow)$, which makes it appear as though A has experienced a negative local demand shock.

  – If B experiences a positive demand shock $(P_B \uparrow, Q_B \uparrow) \Rightarrow P_A \uparrow \Rightarrow Q_A \uparrow$, then $(P_A \uparrow, Q_A \uparrow)$, which makes it appear as though A has experienced a positive local demand shock.

  – If B experiences a negative demand shock $(P_B \downarrow, Q_B \downarrow) \Rightarrow P_A \downarrow \Rightarrow Q_A \downarrow$, then $(P_A \downarrow, Q_A \downarrow)$, which makes it appear as though A has experienced a negative local demand shock.

  – If Market A experiences a negative supply shock $(P_A \uparrow, Q_A \downarrow) \Rightarrow P_B \uparrow \Rightarrow Q_B \uparrow$, then $(P_B \uparrow, Q_B \uparrow)$, which makes it appear as though B has experienced a positive local demand shock.

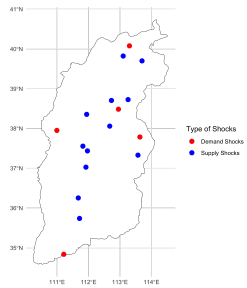
  – If A experiences a positive supply shock $(P_A \downarrow, Q_A \uparrow) \Rightarrow P_B \downarrow \Rightarrow Q_B \downarrow$, then $(P_B \downarrow, Q_B \downarrow)$, which makes it appear as though B has experienced a negative local demand shock.

  – If B experiences a positive demand shock $(P_A \uparrow, Q_A \uparrow) \Rightarrow P_B \uparrow \Rightarrow Q_B \uparrow$, then $(P_B \uparrow, Q_B \uparrow)$, which makes it appear as though B has experienced a positive local demand shock.

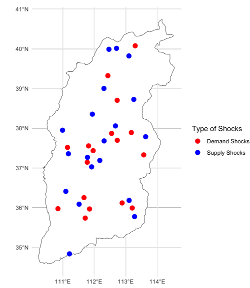
  – If A experiences a negative demand shock $(P_A \downarrow, Q_A \downarrow) \Rightarrow P_B \downarrow \Rightarrow Q_B \downarrow$, then $(P_B \downarrow, Q_B \downarrow)$, which makes it appear as though B has experienced a negative local demand shock.

- Notice that regardless of whether a market experiences a positive or negative shock, the trading partner will always appear to experience a demand shock. This implies that if a market appears to experience a supply shock, it cannot be the result of shocks transmitted from other markets but must instead reflect an actual local supply shock.

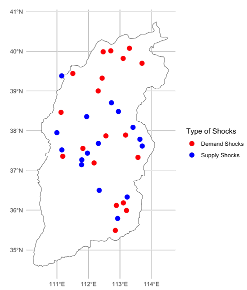
3.D Shocks in Shansi



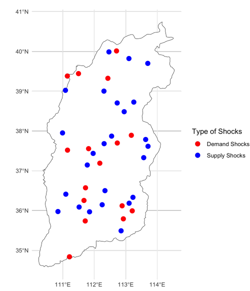
(a) Shansi 1913



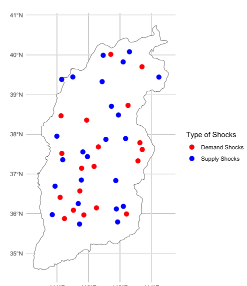
(b) Shansi 1914



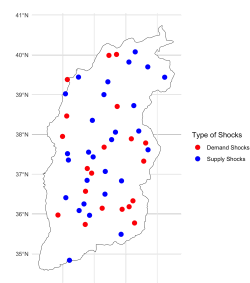
(c) Shansi 1915



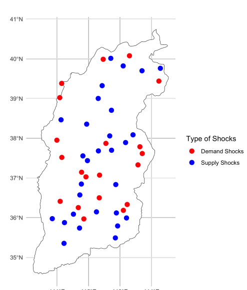
(d) Shansi 1916



(e) Shansi 1917



(f) Shansi 1918



(g) Shansi 1919

Figure 3.D3: Shocks in Shansi

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